CQ535

8. The failure to account for the effects of induced demand seriously undermines the reliability, accuracy, credibility and validity of VMT estimates used to develop regional transportation plans, evaluate alternatives to proposed plans and projects, and to estimate regional emissions from motor vehicles. DOT must address this serious deficiency that undermines the acceptability of regional transportation plans, NEPA reviews of alternatives and conformity determinations under the Clean Air Act wherever induced demand is not fully accounted for. Environmental Defense requests that DOT issue guidelines that require agencies to use state-of-the-art modeling tools to account for this effect whenever regional transportation plans, EIS/EA reviews or conformity determinations are being performed as part of the regional planning, conformity or NEPA process.

9. Environmental Defense requests that DOT support its proposed requirements to consider the disparate impacts of transportation investment policies on low income, racial and ethnic communities by requiring that a) performance criteria be identified by the regional planning agencies, b) that the impacts of past practices and any proposed new or revised regional plan be routinely quantified with respect to such performance criteria as part of the regional planning process, and c) that regional planning agencies adopt target improvements in the performance criteria as part of developing the regional plan.

10. Environmental Defense requests that DOT adopt a national goal to guide the regional planning process to achieve the elimination of disparate impacts of each regional transportation system as required by Title VI of the Civil Rights Act. The goal should be defined as the development of a regional transportation system that ensures equal access to all existing and new places of employment, housing, worship and public facilities by populations that do not own or operate personal vehicles, without imposing disparate cost and travel time burdens on such populations. The rule should require that regional transportation plans adopt strategies to implement the national goal with all deliberate speed.

Environmental Defense appreciates this opportunity to comment on the proposed regulations, and would welcome any further opportunities to explore the issues raised by these comments with the Department.

Respectfully submitted,

Robert E. Yuhnke
Counsel for Environmental Defense

Michael Replogle
Director, National Transportation Program

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[i] Nelson, Arthur C. Effects of Urban Containment on Housing Prices and Landowner Behavior. In *Land Lines*, Cambridge, MA: Newsletter of the Lincoln Institute of Land Policy, May 2000 Volume 12 , Number 3, www.lincolninst.edu.

CQ535

Attachment 6: December 4, 2000

Transportation Secretary Rodney Slater
U.S. Department of Transportation
400 7th St SW
Washington, DC

Dear Secretary Slater:

One of the consequences of urban development during the past half century has been the erection of barriers to mobility that have imposed inequitable burdens on many African-Americans, Latinos and other racial, ethnic, disabled and age minorities in the U.S. These Americans often do not share in America's economic progress in part because they are denied access to the majority of new jobs, affordable housing, educational and entrepreneurial opportunities located in new suburbs where access is restricted to those who drive cars. Woefully inadequate or non-existent transit services outside the urban core deny equal access to all who live in America's cities and depend on public transportation for their mobility. To ensure equitable transportation services for the elderly, the young, disabled and those who cannot afford to drive, these barriers to equal access must be overcome.

Federal transportation laws require metropolitan areas, acting through regional planning agencies, to develop regional transportation plans that guide the future expansion of urban transportation systems. Congress has directed that metropolitan areas adopt 20-year plans that "encourage and promote the safe and efficient management, operation, and development of surface transportation systems that will serve the mobility needs of people...." 23 U.S.C. §134(a)(1) and (2). Once adopted, these plans govern the expenditure of federal and State transportation funds in metropolitan areas.

All federally funded programs, including the transportation programs developed through regional transportation plans, are subject to the requirements of Title VI of the Civil Rights Act. Title VI and its regulations prohibit recipients of federal funds from engaging in intentional discrimination on the basis of race, color or national origin, as well as unjustified adverse disparate impact discrimination for which there are less discriminatory alternatives. Title VI provides that "[n]o person in the United States shall on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance." *42 U.S.C. § 2000d.*

The federally funded transportation systems developed in most American cities during the last half century deny the benefits of regional mobility and equal access to the 30%, or more, of Americans who cannot or do not drive personal vehicles. The new transportation planning rules, that you recently proposed to implement the Transportation Equity Act for the 21st Century, seek to begin the process of reversing the inequities of past transportation investment practices. Among other improvements in the metropolitan planning process that would be required by the proposed rules, DOT would require planning agencies to assess the disparate impacts of the current transportation system and develop plans that begin to remedy those impacts.

CQ535

We applaud you for launching this initiative to remedy the adverse social and equity effects of transportation systems in many metropolitan areas that rely almost exclusively on highway development with no comparable expansion of the transportation services needed by those who do not drive. However, we are concerned that the proposed rules contain no clear standard against which regional mobility for all people is to be judged. Without clear direction in the federal rule, we are not sure that your initiative will achieve significant results.

We propose the adoption of a national mobility goal to measure the performance of metropolitan transportation systems. The goal can provide a benchmark for evaluating whether metropolitan areas with clearly inadequate transportation systems are investing in the strategies needed to remedy the inequities of past practices.

This national mobility goal could foster development of regional transportation systems that serves the whole population by ensuring that those who are dependent on means of travel other than driving a car are served equally with regard to essential mobility criteria. These criteria for measuring performance of transportation systems should include, at a minimum, evaluation of whether the systems are designed to --

- ensure equal access to employment opportunity, affordable housing, educational and community facilities, health services, and places of worship in various portions of the metropolitan area through the Regional Transportation Plan;
- ensure early substantial progress towards this equal access mobility goal through the Transportation Improvement Program; and
- ensure that those who are transit-dependent or rely on shared-ride services do not face increased travel cost, travel time, safety hazards, or degradation of travel conditions compared to those who drive personal vehicles.

We ask that language be added to the proposed rule to define the mobility goal as "the development of a regional transportation system that ensures equal access to all places of employment, housing, worship and public facilities, including access for populations that do not own or operate motor vehicles, without imposing disparate cost and travel time burdens on such populations." The rule should require that "regional transportation plans and Transportation Improvement Programs adopt strategies to implement the national mobility goal with all deliberate speed."

We seek your support for the adoption of this goal as part of the metropolitan planning rules soon to be issued by the Department of Transportation. The adoption of a national mobility goal can lay the foundation for the development of future transportation systems that will break down the mobility barriers to equal access in American cities. Issuing regulations that effectively promote equal access could be an important legacy of this Administration to those who need a hand up, not a hand out.

Sincerely,

Rep. John Lewis
Rep. Edolphus Towns
Rep. Carolyn Kilpatrick
Rep. Elijah Cummings
Rep. Cynthia McKinney

CQ535

Planning for Sustainable Development in California

Robert A. Johnston

University of California, Davis

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Sustainable Development Planning

- Don't harm future generations. Long-range view.
- Objectives:
  - Economic Welfare
  - Social Equity
  - Environmental Quality
- "It is better to be roughly right than exactly wrong." **Long-range comprehensive planning.**
- MPOs now do short-range planning for narrow objectives. So, they are "Exactly wrong."

Global and U.S. Progress on Sustainable Development Planning

- Global: Aggregate income up; income disparity worse, more starvation; greenhouse gases worse, fisheries crashing, habitats destroyed.
- U.S.: Income up; income disparity worse; greenhouse gases worse, AQ better, WQ same or worse, habitats destroyed.
- **So, need emphasis on Social Equity and Environmental Quality.**

Role of MPOs in SD Planning

- National Governments do hard policies on:

  population, immigration, religion, debt relief, war, income taxation, infrastructure, monetary policy, property rights, women's rights, energy and pollution pricing, welfare/health care/retirement, etc.

- State Governments do:

  rail and freeways, state habitat plans, land use laws, local finance, school finance, etc.

- MPOs do:

  transportation planning and advisory land use planning.

  But, transportation systems affect everything. Need accounting.

CQ535

Calif. Demonstrations: Small MPO

- Merced Co. Assoc. of Govts.
- 211,000 pop. in 2000. San Joaquin Valley. Severe AQ nonattainment. Worsening.
- USEPA and FHWA Partnership for Integrated Planning demonstration. Caltrans supports.
- All Fed., St., and local agencies together, doing RTP using land use and travel models.
- Selected UPlan, my simple GIS land use allocation model, iterated with their 3-step travel model. Land uses are allocated in 50m cells.

CQ535

Merced Co., cont'd

- Attention to effects of urban growth on habitats and ag. lands. Univ. of Calif. Campus. HSR. UPlan can also forecast erosion and water pollution. Models done. Application in FY 03.
- Travel model will give mobile emissions and energy use in vehicles.
- Will add mode choice to travel model. Then, could get traveler surplus (Small-Rosen) by household income class. Partial economic welfare & social equity measures.
- **Fed. and St. agencies finding Env. Planning hard to do. Used to regulating. Ex: How much habitat is enough?**

CQ535

Calif. Demonstrations: Large MPO

- Sacramento MPO. 1.9 M pop. 2000.
- May not show AQ conformity in next MTP round, due to new St. emissions inventory.
- Three new freeways in MTP. Will induce sprawl onto ag. lands and habitats. Lawsuits.
- Advanced 5-step travel model. LRT. TODs planned by Sacramento City and Co. The Co. has a UGB, but sprawl in outer counties. **Transit with sprawl is costly.**
- MPO starting to do long-range scenarios this Fall.

CQ535

Sacramento, cont'd

- UC Davis and U. of Calgary team has applied MEPLAN for several years. Studies for UC Transportation Ctr., EPA, and Mineta Fdn. Independent of MPO.
- May go to PECAS in 2003 and Oregon2, later. Could get aggregate economic welfare measure and social equity measures, such as:
  - economic welfare for households by income
  - housing costs for households by income
  - economic welfare for firms by type by zone

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Sacramento, cont'd

- Will disaggregate PECAS land consumption from 160 subdistricts to 1,000 zones, using UPlan GIS model. Have parcel data for region.
- Then, will run MPO travel model, to get mobile emissions and energy use.
- With UPlan (or Oregon2) footprint, can run GIS impact models for habitat damage, erosion, WQ, loss of ag. lands, local service costs, costs from flooding, costs from wildfires, etc.

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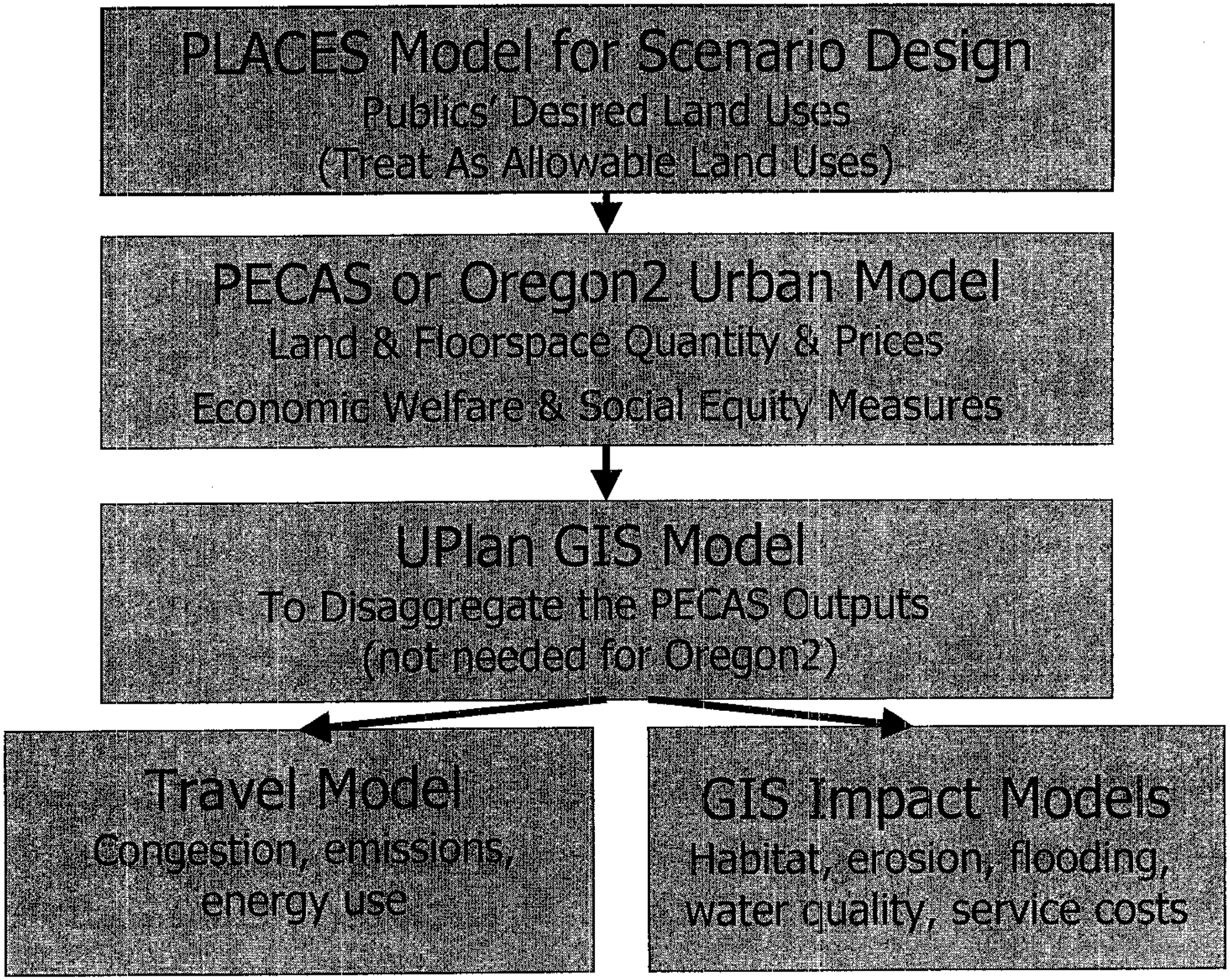
Sacramento, cont'd

- The scenario generation will be done by the MPO with the PLACES model. Freeware. Public workshops.
- Neighborhoods are planned with parcels, communities and counties with planning districts. Evaluation spreadsheets.
- We'll take the charette land uses into PECAS (or Oregon2) as changes in allowable land uses. This allows them to represent the land market properly.
- Together, the models will give all the SD Planning measures.

MOE: The Model of Everything



Other California Programs

- SANDAG doing compact growth scenarios, to protect habitat lands. PLUM/EMPAL plus GIS.
- ABAG doing compact growth scenarios, to reduce service costs, travel, and emissions, using PLACES model and travel model.
- SCAG counties doing habitat plans. Big nonpoint WQ problems. May do land use model.
- California High Speed Rail Commission may fund a statewide PECAS model.
- PLACES on Web. Landis' CURBA model on Web.
- Irvine Fdn. will support Sacramento and S. Diego regions for SD Planning, for 3-5 years.

Conclusions

- SD Planning requires models that can measure Economic Welfare, Social Equity, and Environmental Quality.
- With PECAS (zones) or Oregon2 (cells), we can now do the first two. Thank you, Oregon DOT.
- GIS and other conventional models can measure various aspects of Environmental Quality, local service costs, etc.
- Can now do 40-year scenarios and **look at the big tradeoffs**. UGB v. housing costs. Freeways and sprawl v. transit and jobs for the poor. Get it "Roughly right."
- Can we increase Social Equity and Env. Quality, and Economic Efficiency? (Hint: transit, TODs, and pricing.)

What Next?

- Make the process **relevant** to the public with maps, birdseye oblique drawings or 3-D GIS, and narratives. Issues: Traffic, housing costs, open space.
- Develop model feedbacks from Env. Quality to Economic Welfare. Ex: open space affects property values.
- Develop model feedbacks from Social Equity to Economic Welfare. Ex: high income disparity causes? low regional growth rate.

What's Next, cont'd

- **Identify problems** for State and Federal governments to fix. Ex: population growth, local finance.
- Validate models carefully with historical forecasts, sensitivity testing, and heuristic use.
- Get academic units to also run models, advise MPOs, and train students.
- **Need USDOT to require alternatives in MTPs.** Need USEPA to fund more integrated planning exercises. Need state DOTs to fund MPOs to do alternatives analyses.

CQ535

CQ535

tfreuder@environmentaldefense.org

09/23/02 02:25 PM

To: ceq_nepa@fs.fed.us
cc:
Subject: Additional Attachments Env Defense Comments to NEPA task force

(See attached file: Wert-OMIP[1].ppt) Wert-OMIP[1].ppt

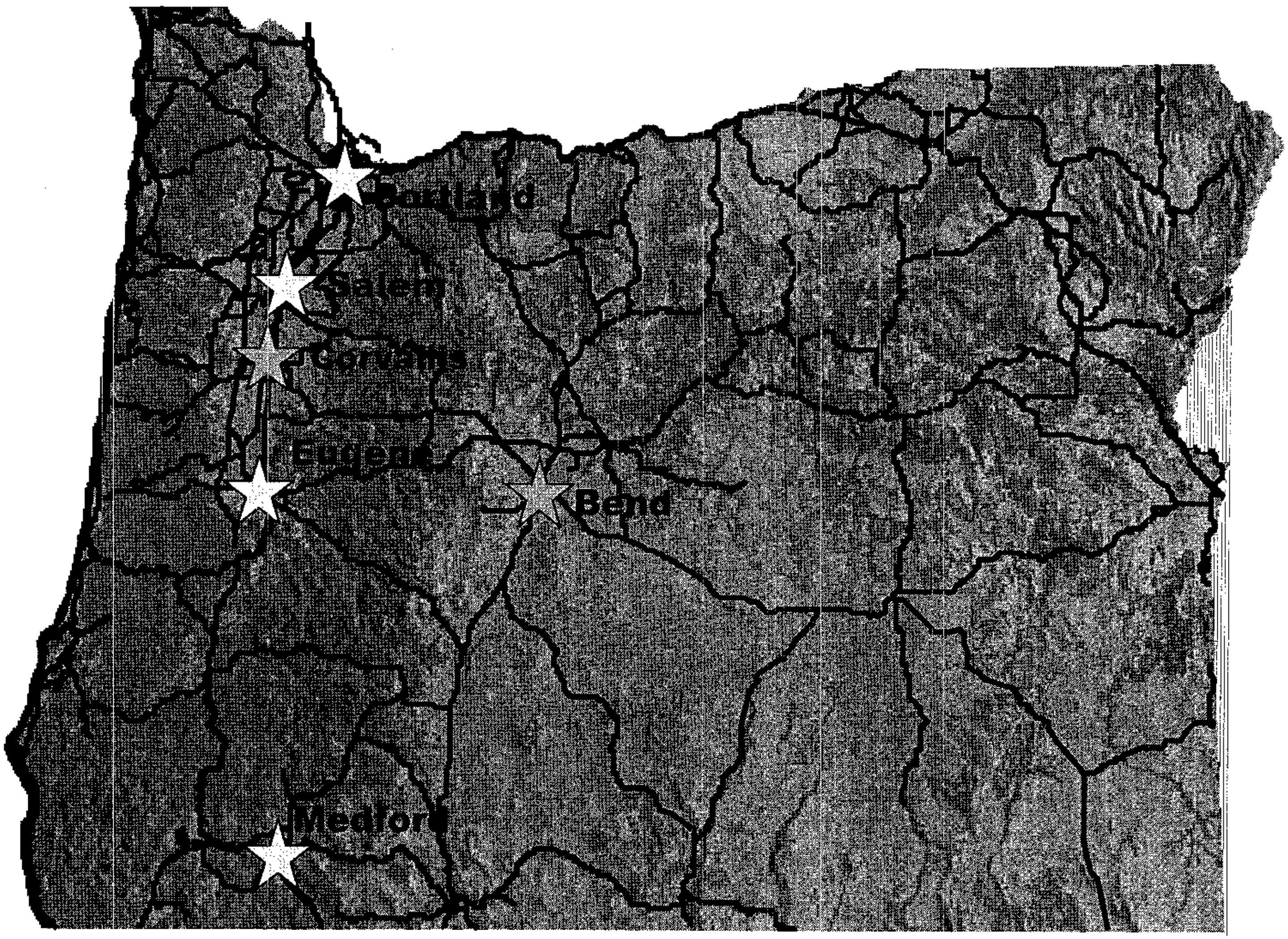
OREGON MODELING IMPROVEMENT PROGRAM

Third Oregon Symposium on Integrated Land Use & Transport Models

July 23, 2002

WELCOME TO OREGON

MPO



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EARLY MODELING IN OREGON - 1990s

- Modeling done for air quality conformity, major project development
- Metro, ODOT, LCOG did transportation modeling
- RVCOG and MWVCOG relied on ODOT
- Modeling only in MPOs and Bend
- Even then, Metro was a leader

CQ535

1990s MANDATES

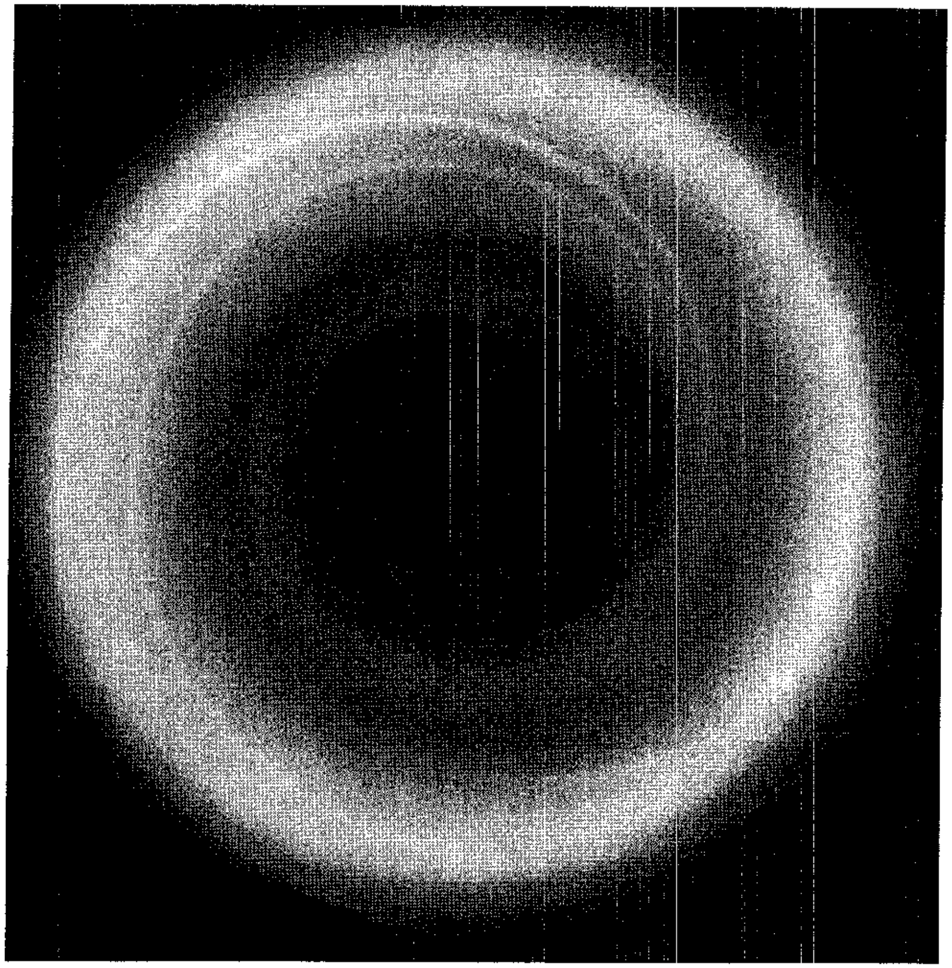
- Clean Air Act Amendments (CAAA)
- Transportation Efficiency Act (TEA 21)
- Oregon Transportation Planning Rule (TPR)
- Oregon Growth Management and Quality Communities Policies

WHY DID OREGON START OMIP?

- Modeling methods were outdated
- Content with "all or nothing" ADT model
- Drifting away from acceptable modeling practices
- Could not meet agency requirements
- Could not provide vital information in a timely manner
- ODOT losing ability to effectively participate in decision-making in Oregon

CQ535

Oregon had entered the



of transportation modeling

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FIRST STEP

- Establish best practice modeling guidelines
- Perfect transport models before moving to integrated models
- California only state with documented minimum tolerance levels
- Parsons Brinckerhoff promised to do even better for ODOT

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CHANGE IN PHILOSOPHY

The type of analysis required for an area dictates the level of model sophistication, not population.

Importance: Set precedence for modeling for Transportation System Plans in small jurisdictions.

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NEXT STEP

- Communication among agencies is the norm, not the exception
- MPOs, ODOT, DEQ, DLCD discussing best practice guidelines
- Started the Oregon Modeling Steering Committee (policy) and Users Group (technical)
- Agreement that this would be a voluntary program

CQ535

GROWING PAINS

- Regulatory agencies wanted mandatory guidelines under state air quality conformity rule
- ODOT planners wanted required consultation for Transport Improvement Plan development
- Small MPOs wanted to talk technical not big picture
- Oregon GIS program wanted total control

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AND MORE GROWING PAINS

Built a best practice model in Salem/Keizer

- ODOT and MWVCOG staff do work with consultant guidance
- Document process
- Prepare model development procedures manual

Communications broke down
Ran out of time and money
Competing expectations
Everyone unhappy

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LESSONS LEARNED

- Local groups work well together
- Technical folks quickly build good working relationships
- Consultants can get in the way
- Federal TMIP affirmed Oregon vision

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AND NOW THE REAL CHALLENGE

- Management understanding and buy-in
- Funding

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FIRST GENERATION MODEL

- Mid-1990s
- Developed 5 tracks - resources, outreach, development, implementation, data
- Brought all stakeholders together for 3-day workshop
- Conducted policy-maker interviews
- Integrated model highest priority
- Prepared Request for Proposal/hired consultant

STEERING COMMITTEES

1995	Oregon Modeling Steering Committee (OMSC) formalized
1996	Transportation-Land Use Model Integration Program (TLUMIP) Peer Review Panel

CQ535

DATA & EDUCATION BLITZ

Data

- Collected data from all over Oregon
- Convened Delphi panel to fill voids

Training

- Huge training budget
- Trained the "experts" and everyone else

WHY IS OREGON CONTINUING OMIP?

- Interactions between the state's economy, land use and transportation are complex and interrelated
- Relationships of different modes affect mobility needs
- Decision-makers need estimates of results to make good policy choices
- Policy documents need tools to measure success

WHAT DOES OMIP LOOK LIKE TODAY?

HOW DO OMIP AND TLUMIP RELATE?

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OMIP STRATEGIC ELEMENTS

- RESOURCES
  - Funding
  - Qualified Staff
  - Equipment
- OUTREACH
  - Oregon Modeling Steering Committee
  - Peer Review Panel
  - Statewide Modeling User Group
  - Training & Education
  - Information Sharing
  - Communication
  - Formal Education
- DEVELOPMENT
  - Research
  - Joint Model Development
  - Rural Joint Model Estimation
  - Urban Joint Model Estimation
  - Model Enhancements
  - Documentation Enhancement
  - TRANSIMS
  - Transportation & Land Use Model Integration Program
- IMPLEMENTATION
  - Standards
  - Protocols
  - Case Studies
- DATA
  - Household Activity & Travel Survey
  - Recreation/Tourism Activity Survey
  - Oregon Travel Behavior Survey
  - Longitudinal Panel Survey
  - Commodity Flow Data Collection
  - Freight Shipper and Carrier Survey
  - Truck Intercept Survey
  - Truck Generation & Distribution Survey
  - Geographical Information System

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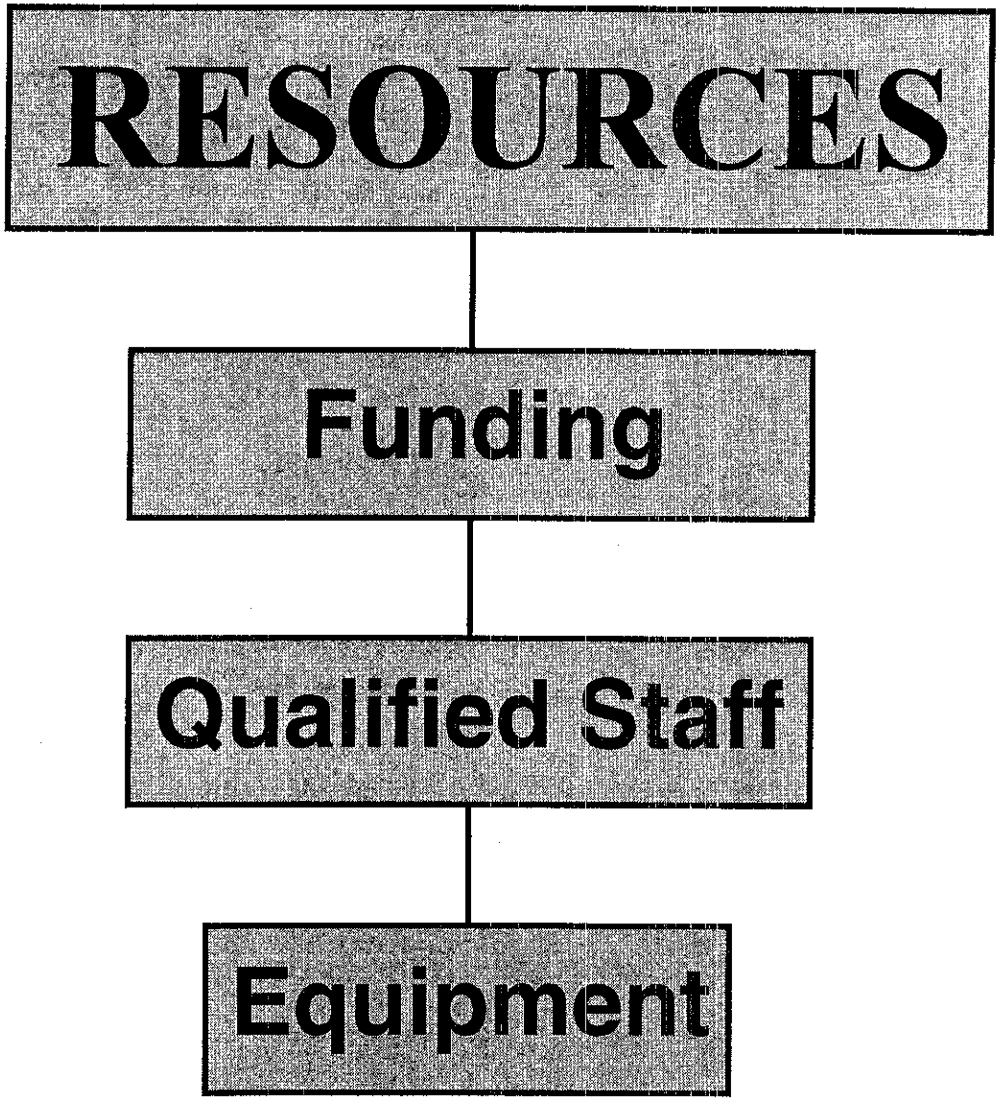

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OUTREACH

Oregon Modeling Steering Committee

Peer Review Panel

Statewide Modeling User Group

Training & Education

Information Sharing

Communication

Formal Education

CQ535

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DEVELOPMENT

Research

Integrated Model Development

Urban Joint Model Estimation

Rural Joint Model Estimation

Model Enhancements

Documentation Enhancement

TRANSIMS

Transportation/Land Use Model Integration Program

IMPLEMENTATION

Standards

Protocols

Case Studies

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DATA

- Household Activity and Travel Survey
- Recreation/Tourism Activity Survey
- Oregon Travel Behavior Survey
- Longitudinal Panel Survey
- Commodity Flow Data Collection
- Freight Shipper and Carrier Survey
- Truck Intercept Survey
- Truck Generation and Distribution Survey
- Geographical Information System

THE BOTTOM LINE IS:

We think about things in a different way.

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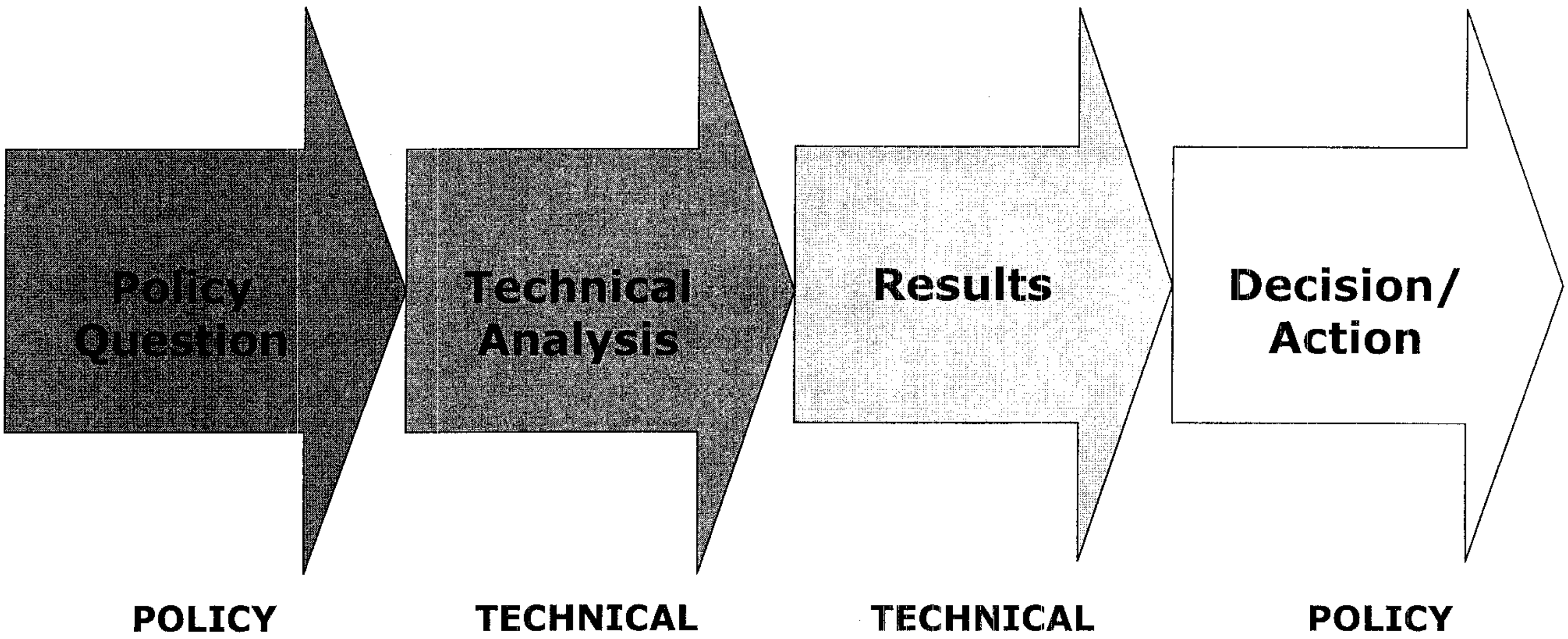
LINEAR DECISION-MAKING PROCESS



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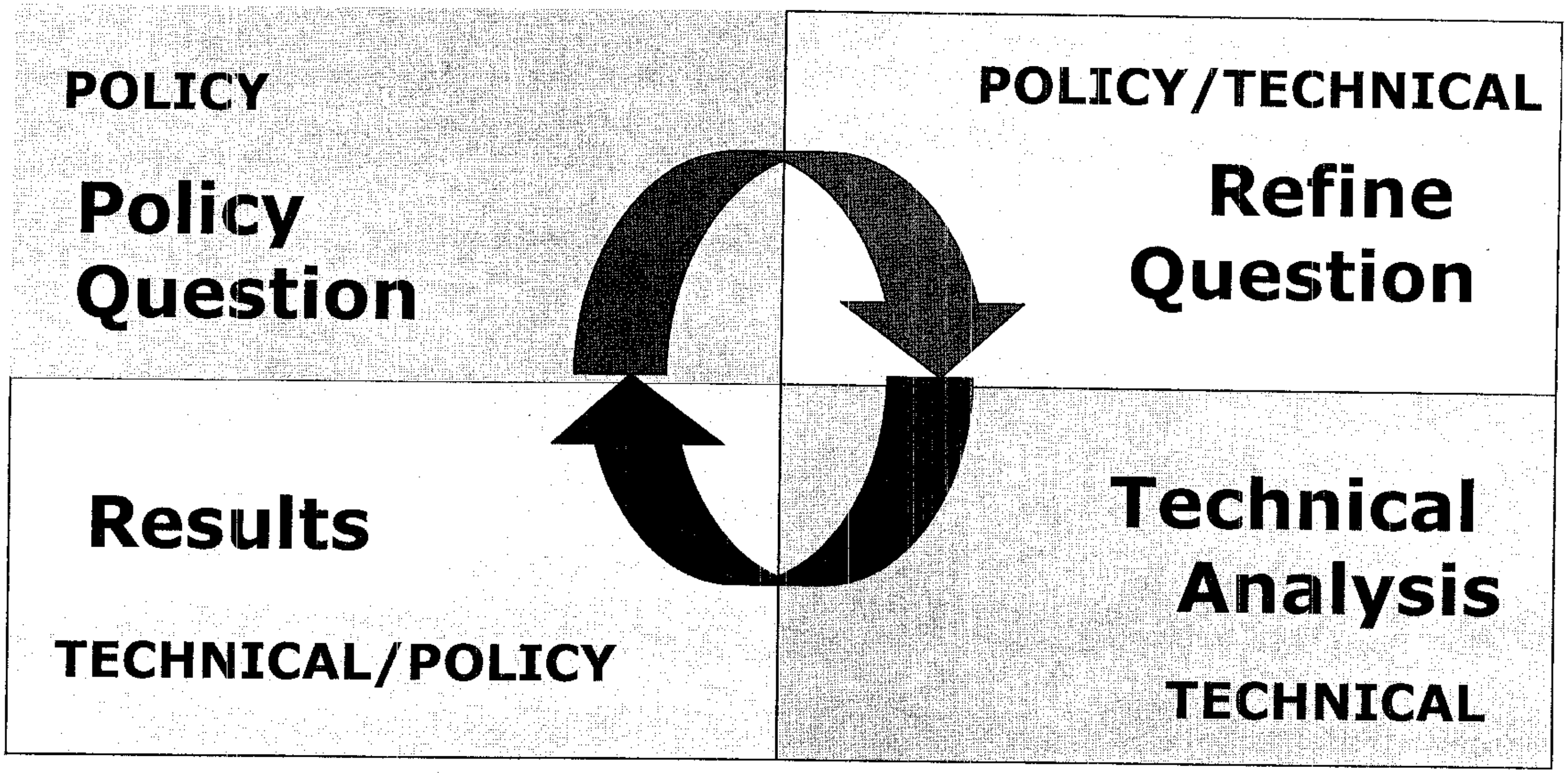
INTERACTIVE & ITERATIVE DECISION-MAKING PROCESS



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CST AND TRADITIONAL APPROACHES TO COMMUNITY DEVELOPMENT

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Traditional Approach

ODOT → Solutions *(Projects/Programs)* → Outcomes
DLCD → Solutions *(Projects/Programs)* → Outcomes
OECDD → Solutions *(Projects/Programs)* → Outcomes
OHCS → Solutions *(Projects/Programs)* → Outcomes
DEQ → Solutions *(Projects/Programs)* → Outcomes

Sum of Solutions — Total Net Outcomes

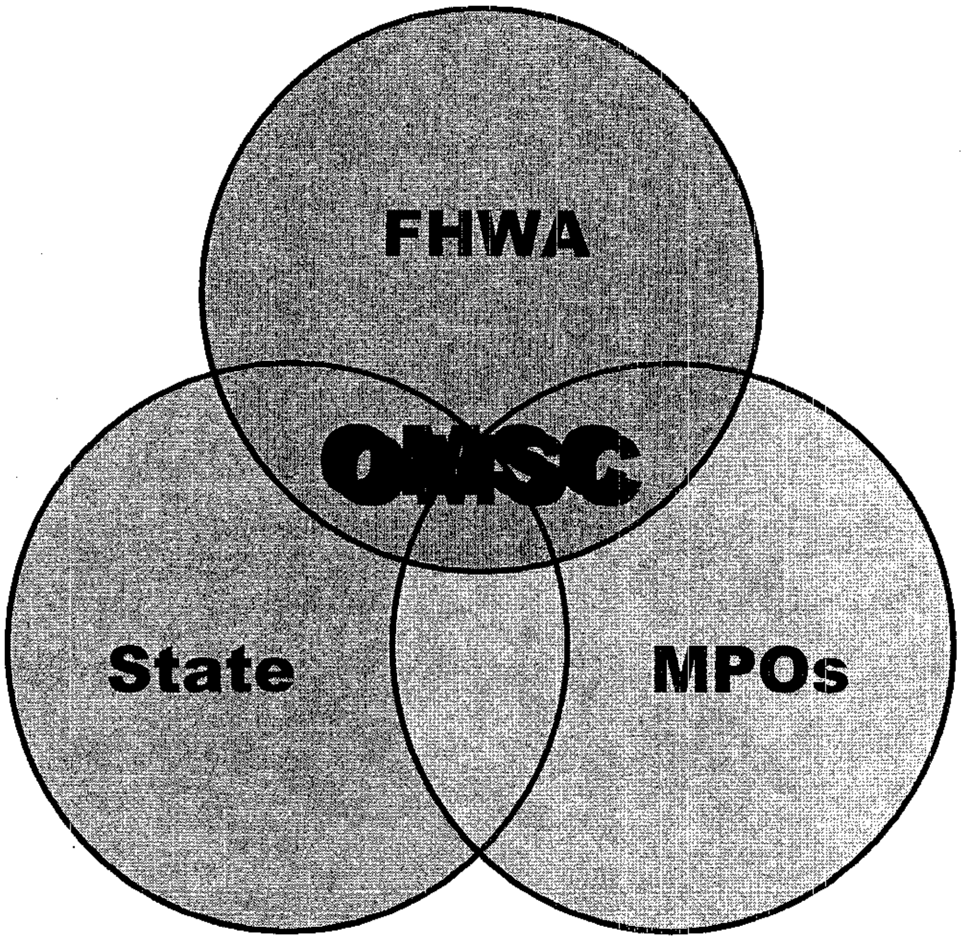
Community Solutions Team Approach

ODOT
DLCD
OECDD → CST Process → CST Solutions *(Projects/Programs)* → CST Outcomes
OHCS
DEQ

OREGON MODELING STEERING COMMITTEE

Partnership among federal, state and local agencies and jurisdictions

CDO
ODOT
DEQ
OECDD
OCHD
DLCD



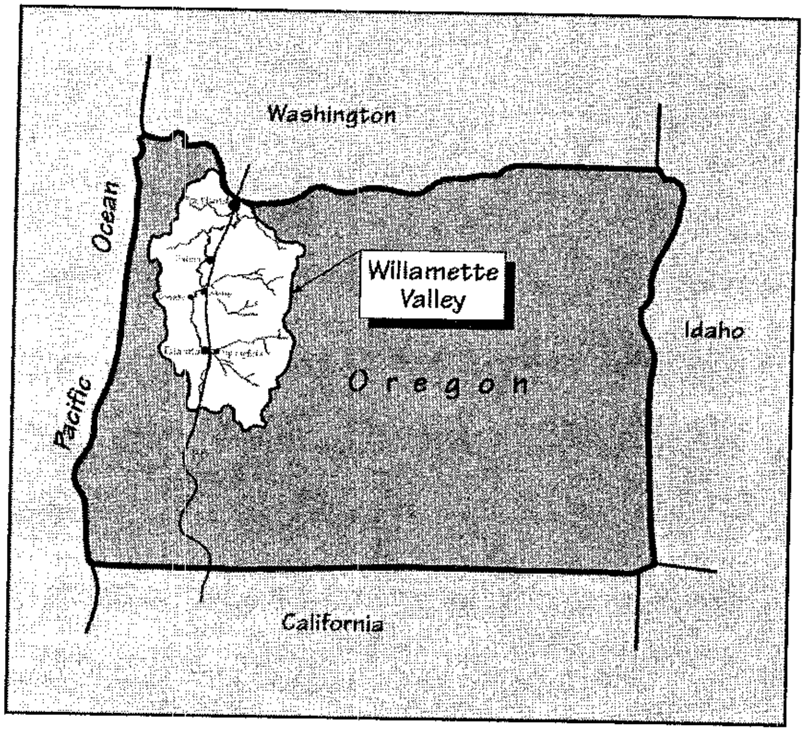
Metro
MWVCOG
LCOG
RVCOG
Bend
Corvallis

CQ535

HOW ARE WE USING OUR MODELS?

BIG PICTURE BRAINSTORMING ON POSSIBLE FUTURES

Willamette Valley Livability Forum Alternative Transportation Futures



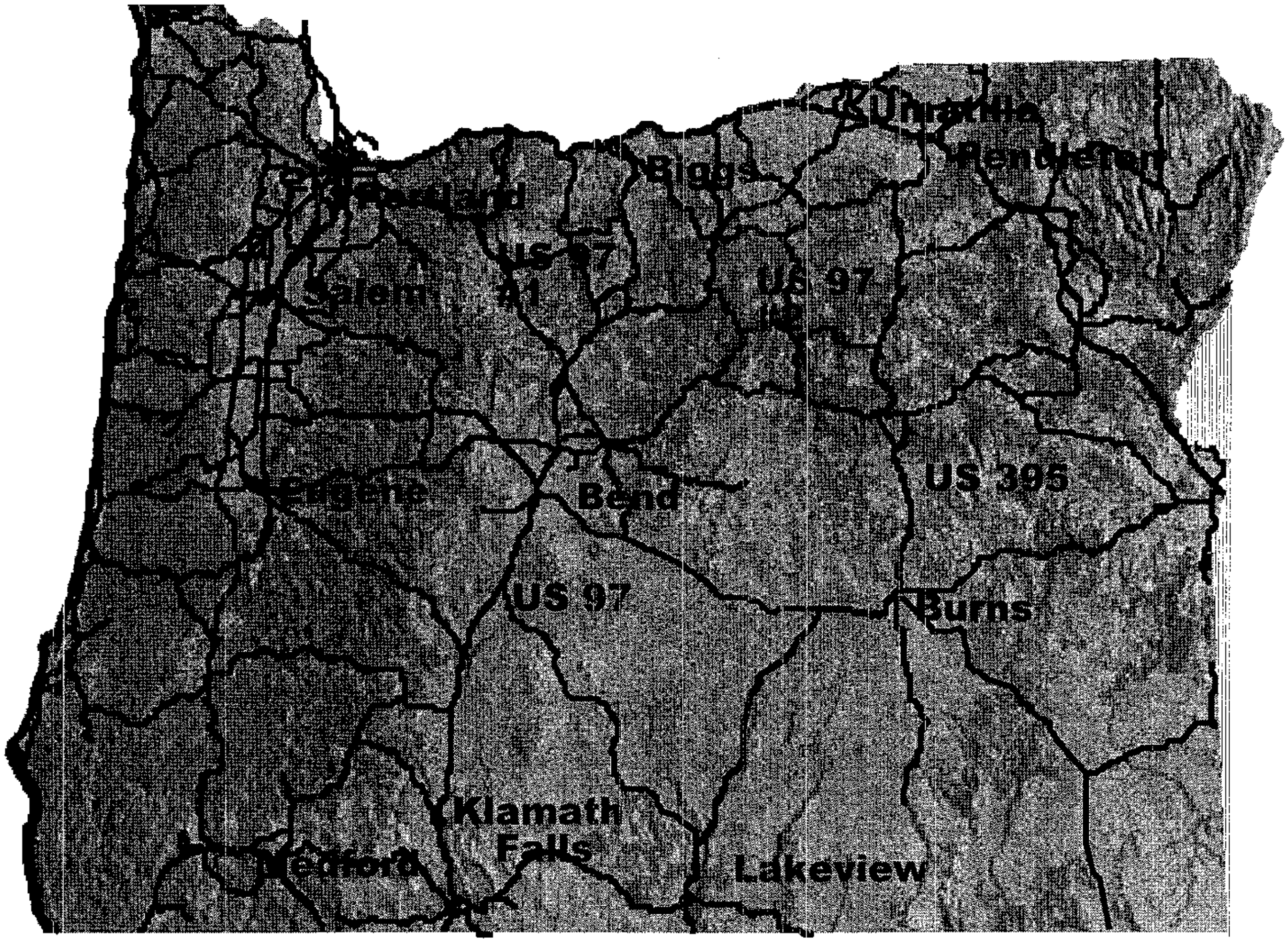
Purpose

A long-range, comprehensive, regional look at the future of land use and transportation in the Willamette Valley.

CQ535

INFRASTRUCTURE INVESTMENT DECISIONS

House Bill 3090 Alternatives



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INDUCED GROWTH ANALYSES

Newberg-Dundee Bypass Environmental Impact Statement

Statewide model used to look at:

- # of households/jobs in the Hwy. 99W/18 corridor in Yamhill County
- Passenger and truck trips to/from the corridor
- Passenger and truck *miles* traveled
- Passenger and truck *hours* traveled

CQ535

INFRASTRUCTURE PRIORITIZATION

Oregon Bridge Deficiency Analysis

Identify economic, land use and transport impacts:

- Load-limiting bridges
  - costs to trucking industry
  - costs to consumers
  - land use changes
- Diversions because of key bridge closures
- Prioritize future bridge investments

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JOINT MODELING PROJECTS

Objective:

Develop *best* models using data from all four Oregon MPO areas and 8-counties.

- Urban Joint Model Estimation
- Rural Joint Model Estimation

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HOW DOES THIS PROGRAM HELP ODOT?

- Help Oregon meet federal and state mandates
- Make better choices for transportation investments
- Tools to address Governor's sustainability and quality communities agenda
- Assist CST in multi-agency decision-making
  - Support local priorities
  - Holistic and integrated decisions
- Foster collaboration and maximize resources (staff, funds)

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NEXT STEPS

- ***Resources***
  - Streamlined cooperative modeling program
  - Reinforce multi-agency and jurisdictional cooperation
- ***Outreach***
  - Extensive outreach to inform and engage users
    - Inside and outside of Oregon
    - Inside and outside of ODOT
  - 3rd Integrated Modeling Symposium in July
  - North American and European consortium

NEXT STEPS

- ***Development***
  - Complete next generation of statewide model
  - Build interactive link between statewide model and local urban and rural models
  - Expand interactive capabilities of urban models
  - Incorporate environmental considerations
- ***Implementation***
  - High profile modeling projects
  - Day-to-day support of cities, counties, state agencies
- ***Data*** - Longitudinal panel survey

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NEXT CHALLENGES

- Institutionalize the program - within ODOT, universities, schools

- Build European partnerships - needs to be broader than the U.S. for the next efforts

- Move beyond research - JUST DO IT!

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THE MEASURE OF SUCCESS

"Become the way Oregon does business"

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tfreuder@environmen
taldefense.org

09/23/02 02:25 PM

To: ceq_nepa@fs.fed.us
cc:
Subject: Additional Attachments Env Defense Comments to NEPA task force (LUTRAQ)

(See attached file: LUTRAQvol 5_ch 2.pdf)(See attached file: LUTRAQVol7_A_preface.pdf)(See attached file: LUTRAQvol5_ch1.pdf)(See attached file: LUTRAQvol5_ExecSum.pdf)(See attached file: LUTRAQvol7_A_growth.pdf)(See attached file: LUTRAQVol4summary.pdf)(See attached file: LUTRAQVol8ch1.pdf)(See attached file: LUTRAQvol7_B_change.pdf)(See attached file: LUTRAQvol7_C_cases.pdf)(See attached file: LUTRAQvol7_E_acknowlg.pdf)(See attached file: LUTRAQvol7_F_referenc.pdf)(See attached file: LUTRAQVol7_A_titlepg.pdf)(See attached file: LUTRAQVol8references.pdf)(See attached file: LUTRAQVol8execsum.pdf)(See attached file: LUTRAQVol8ch3.pdf)

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LUTRAQvol5_ch1.pdf
LUTRAQvol5_ExecSum.pdf
LUTRAQvol7_A_growth.pdf
LUTRAQVol4summary.pdf
LUTRAQVol8ch1.pdf
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Chapter 2: Transportation, Air Quality, Greenhouse Gas & Energy Analyses

This chapter presents the results of simulating each of the alternatives described in the previous chapter through the year 2010. The analyses show that by focusing land uses in moderately dense, mixed use, pedestrian designed locations served by transit and supported by demand management policies, the LUTRAQ alternative makes a substantial difference in travel behavior and air quality. The LUTRAQ alternative significantly reduces the need to own multiple vehicles, or even any vehicle at all. The alternative also reduces vehicle miles traveled and increases walking, bicycling, and transit use. Air pollution, greenhouse gas emissions, and energy consumption are also reduced.

Auto Ownership

The LUTRAQ study area today is more auto dependent than the region as a whole. Only 1.2 percent of person trips in the study area are by transit, compared to 3.4 percent of the person trips in the region. This is at least partially a result of the social and economic characteristics of study area residents, who are more affluent than residents in much of region. In addition, these residents are less well served by transit and live in developments that are lower in density and less pedestrian friendly than more centrally located portions of the region. Thus, it is significant that the LUTRAQ alternative reduces auto ownership rates in the year 2010 over what they would be without changes in land use policies or transportation investments.

Table 2-1: Auto Ownership

Percentage of Homes Owning:	No Build	Highways Only	Highways/ Parking Pricing	LUTRAQ	LUTRAQ (TOD Only)	LUTRAQ/ Congestion Pricing	LUTRAQ/ Congestion Pricing (TOD Only)
0 Auto	2.9	3.0	3.0	4.9	9.1	5.6	9.7
1 Auto	26.5	26.8	26.8	29.2	35	30.2	35.6
2 Autos	47.6	47.7	47.7	44.8	40.1	43.7	39.6
3 Autos	23	22.5	22.5	21.1	15.8	20.4	15
Average Autos/ Household	1.91	1.9	1.9	1.82	1.63	1.79	1.6

Table 2-1 shows the estimated percentage of households that would own various numbers of autos under each of the alternatives. The Highways Only alternative would not change auto ownership rates, but the LUTRAQ alternative would reduce the average number of autos per household by five percent compared to the No Build alternative. The number of households with only one car, or no car at all, would increase with the LUTRAQ alternative.

The main reason for these changes in auto ownership can be seen in the TOD columns of Table 2-1 that show the auto ownership levels in the transit oriented development (TOD) areas of the LUTRAQ alternatives. About 35 percent of TOD households would choose to own only one car, and over 9 percent would choose not to own a car at all. Only 55 percent of households in the TODs would own two or more cars compared to 70 percent in the study area with the No Build or Highways Only alternatives.[1]

Mode Choice

Mode choice is also strongly influenced by the alternatives. The No Build and Highways Only alternatives would continue the auto orientation of the study area while the LUTRAQ alternative would shift many trips to non-automotive modes. Table 2-2 displays the projected mode shares for 2010 by trip purpose. Figures 2-1 to 2-3 show the results graphically.

It is important to note that the Highways Only alternative would actually decrease auto mode shares slightly as compared to the No Build alternative, especially for work trips. This is most likely the result of including some transit capital improvements in the alternative.

With the LUTRAQ alternative, residents of the study area make more than twice as many work trips by transit than with the No Build or Highways Only alternatives. Carpooling also increases substantially with the LUTRAQ alternative while it declines with the Highways Only alternative.

This shift away from the automobile under the LUTRAQ alternative is primarily the result of two factors. One factor is the TOD development pattern. The share of works trips by walk/bike and transit would be much higher in the TOD areas in the LUTRAQ alternative than in the study area as a whole, as shown in Table 2-2. The significant improvements in transit accessibility and the pedestrian environment, as well as the density and mixture of uses in the TODs, would encourage much greater use of alternatives to the automobile. In the TOD areas, walk, bike, and transit would account for about 30 percent of all home-based trips and 33 to 38 percent of all work trips. These figures, while substantially higher than those in the rest of the study area, are similar to measures of current travel behavior in the pedestrian friendly areas of the City of Portland. This success in reducing auto travel implies that organizing future development beyond 2010 according to transit-oriented development principles could further reduce automobile reliance county wide.

1. TODs are designed with 57.5 percent of housing in multi-family units compared with 37 percent in all of Washington County in 2010. Apartments and condominiums are smaller and attract different households than single family homes. Thus, part of the benefit of TODs is to concentrate smaller households that are likely to own fewer cars near transit stations. In all, the effects of applying the principles of good planning (by locating transit-oriented households near transit) are as important as the effect of applying principles of good design (mixed uses and pedestrian orientation). *See* 1000 Friends of Oregon, *Making the Land Use, Transportation, Air Quality Connection*, Vol. 6, *Implementation* (Portland, Oregon, 1995), Appendix D.

Table 2-2: Mode Choice (by percentage of trips)

	No Build	Highways Only	Highways/ Parking Pricing	LUTRAQ	LUTRAQ (TOD Only)	LUTRAQ/ Congestion Pricing	LUTRAQ/ Congestion Pricing (TOD Only)
HOME BASED TRIPS							
Home Based Work Trips							
Walk/Bike	2.8	2.5	2.5	3.5	5	4	5.7
Auto	89.7	88.7	82.2	78.3	66.7	74.9	62.1
Drive Alone	75.8	75.1	61.7	58.2	49.6	55.3	45.7
Carpool	14	13.6	20.4	20.1	17.2	19.6	16.4
Transit	7.5	8.8	15.3	18.2	28.2	21.1	32.1
Home Based Non-Work Trips							
Home Based Other Trips							
Walk/Bike	3.3	3.1	3.1	3.9	6	4.4	7
Auto	95.6	95.8	95.4	94	90	93.3	88.9
Transit	1.1	1.1	1.5	2.1	4	2.3	4.2
Home Based School Trips							
Walk/Bike	19.4	19.4	19.4	19.4	19.4	19.4	19.4
Auto	29.6	29.7	29.6	29.6	29.6	29.6	29.6
Transit/School Bus	51	50.9	51	51	51	51	51
Home Based College Trips							
Walk/Bike	3.2	3.2	3.1	6	4.3	7.1	4.8
Auto	80.9	80.1	85.2	78.4	77.4	77.8	76.3
Transit	15.9	16.7	11.7	17.3	16.6	17.4	16.6
Total Home Based Non-Work Trips							
Walk/Bike	6	5.8	5.8	6.5	9.9	6.9	10.4
Auto	84	84.2	84.1	82.6	71.1	82	71.8
Transit	10	10	10.1	10.9	18.9	11.1	17.9
Total Home Based Trips							
Walk/Bike	5.1	4.9	4.9	5.6	8.7	6.1	9.2
Auto	85.6	85.4	83.6	81.4	70.1	80	69.3
Transit	9.3	9.7	11.5	12.9	21.2	13.9	21.5
NON-HOME BASED TRIPS							
Non-Home Based Work Trips							
Walk/Bike	0.4	0.4	0.4	0.9	1.7	1.1	2
Auto	98.9	98.9	98.9	98.1	96.5	97.7	96.2
Transit	0.7	0.7	0.7	1	1.8	1.1	1.8
Non-Home Based Non-Work Trips							
Walk/Bike	0.3	0.3	0.3	0.5	0.9	0.7	0.9
Auto	99.1	99	99.1	98.7	98	98.5	97.9
Transit	0.6	0.7	0.6	0.7	1.1	0.9	1.2
Total Non-Home Based Trips							
Walk/Bike	0.3	0.3	0.3	0.7	1.2	0.8	1.4
Auto	99	99	99.1	98.5	97.4	98.2	97.1
Transit	0.6	0.7	0.6	0.8	1.4	1	1.5
TOTAL ALL TRIPS							
Walk/Bike	3.8	3.7	3.7	4.3	6.8	4.7	6.9
Auto	89.1	89	87.7	86	77.2	84.8	77.4
Transit	7	7.3	8.6	9.7	16	10.5	15.7

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Figure 2-1: Percentage of Work Trips by Mode

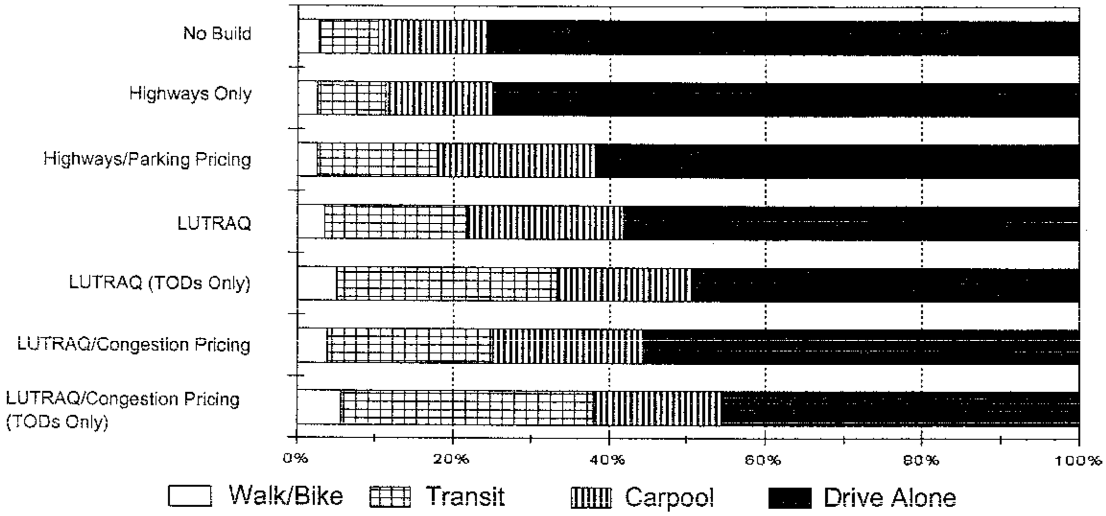


Figure 2-2: Percentage of Non-Work Trips from Home by Mode

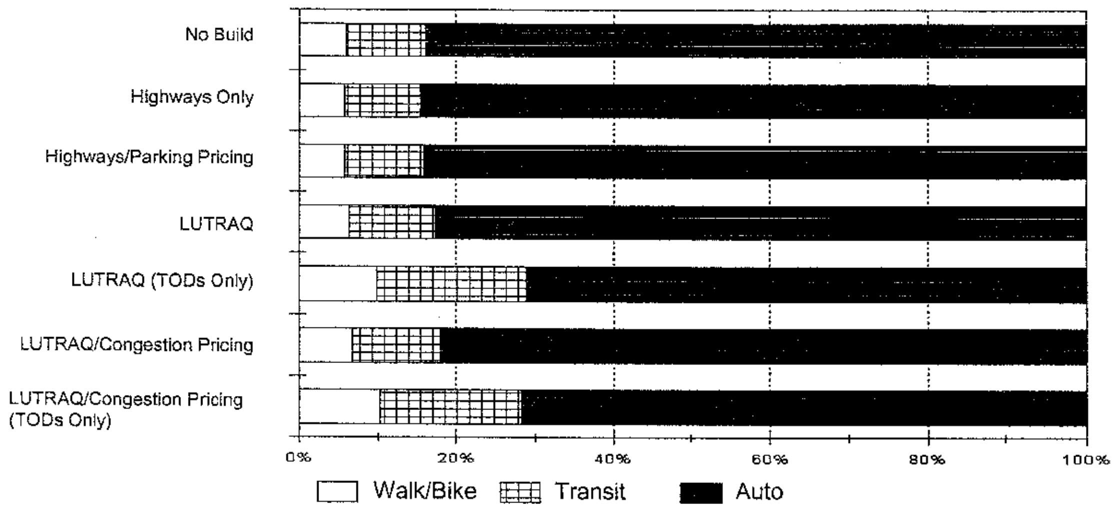
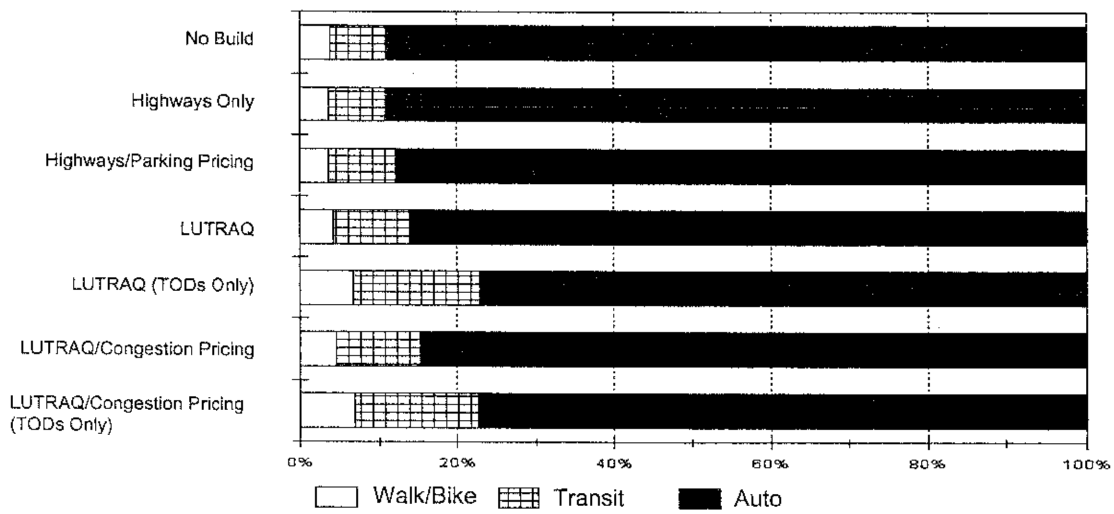


Figure 2-3: Percentage of All Trips by Mode



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The other factor influencing the LUTRAQ alternative's performance is the effect of the parking charges and subsidized transit passes included in the alternative. This effect can be seen by comparing the Highways Only and the Highway/Pricing alternatives, as the pricing alternative contains the same parking charges and transit pass subsidies as the LUTRAQ alternative. Adding parking pricing and transit passes to highway building nearly doubles transit usage for work trips and increases carpooling about 50 percent.

The relative effects of land use and pricing policies can also be seen by comparing the mode shares for two earlier versions of the LUTRAQ package. Table 2-3 shows mode shares for the LUTRAQ/No Pricing and LUTRAQ/Parking Pricing alternatives, and the Base Case to which they can be compared. The LUTRAQ/No Pricing alternative contains only LUTRAQ's transit oriented land use plan and expansions to the light rail system. This package increases the use of transit for the work trip by 30 percent in the study area, but has minimal impact on carpooling. The LUTRAQ/Parking Pricing alternative adds the parking charge/transit pass component to the land use/transit package and boosts transit ridership an additional 36 percent. In addition, the LUTRAQ/Parking Pricing alternative has 50 percent more carpooling trips than the Base Case. In both these alternatives the rates of transit use are highest in the TODs.

In all, the analysis indicates that 48 percent of the increase in non-automobile mode shares for work trips is attributable to the pricing measures, while the balance (52%) is due to the land use/transit changes. Hence, according to the model, the effect of land use/transit is slightly greater than the impact of pricing. On the ground, however, both sets of measures are likely to have a synergistic effect that the model is unable to predict. In other words, under actual conditions, the sum of land use/transit plus pricing is likely to be greater than the parts.

During the analysis of the LUTRAQ alternative, it became apparent that the model was predicting lower walk and bike mode shares than expected. Upon further investigation, it was determined that the data used to calibrate the Metro model—a 1985 travel survey of the Portland area—under reported walk/bike trips, particularly for non-work and non-home based trips in pedestrian friendly areas. Walk/bike shares in the San Francisco Bay area, for example, are significantly higher than those reported in the Portland survey. This problem implies that the Portland travel model does not include all walk/bike trips. While the numbers of auto and transit trips are correct, the estimated number of total non-motorized trips is probably too low.

To correct for this under reporting problem, a set of adjustments to the model's walk/bike trip outputs were developed. This increased walk/bike shares for the LUTRAQ alternatives and correspondingly decreased auto and transit shares, as shown in Table 2-4. It is important to note that these adjustments are made solely to provide more realistic estimates of the walk/bike mode shares. The estimates of the number of auto and transit trips, as well as figures computed from these trips—such as traffic volumes, vehicles miles of travel, etc.—are not affected. Details of the walk/bike share adjustments are described in Appendix C.

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Table 2-3: Effect of Pricing on Mode Choice (by percentage of trips)

	Base Case	LUTRAQ/ No Pricing	LUTRAQ/ No Pricing (TOD Only)	LUTRAQ/ Parking Pricing	LUTRAQ/ Parking Pricing (TOD Only)
Home Based Trips					
Home Based Work					
Walk/Bike	2.8	3.5	5.4	3.5	5.4
Auto	89.5	86.5	80.6	83.6	74.4
SOV	76	72.7	67.5	63.9	56.5
Carpool	13.5	13.8	13.1	19.7	17.8
Transit	7.7	10	14	12.8	20.2
Home Based Non-Work					
Home Based Other					
Walk/Bike	3.3	3.9	6.4	3.9	6.4
Auto	95.7	94.6	90.3	94.6	90.3
Transit	1	1.5	3.3	1.5	3.3
Home Based School					
Walk/Bike	19.4	19.4	19.4	19.4	19.4
Auto	29.7	29.7	29.7	29.7	29.7
Transit/School Bus	50.9	50.9	50.9	50.9	50.9
Home Based College					
Walk/Bike	3.2	4.3	6	4.3	6
Auto	80.1	82	80.6	82	80.6
Transit	16.7	13.7	13.4	13.7	13.4
Total Home Based Non-Work					
Walk/Bike	6	6.5	8	6.5	8
Auto	84.1	83.3	82.1	83.3	82.1
Transit	9.9	10.2	9.8	10.2	9.8
Total Home Based					
Walk/Bike	5.1	5.7	7.3	5.7	7.3
Auto	85.6	84.2	81.7	83.4	80
Transit	9.3	10.2	11	10.9	12.7
Non-Home Based Trips					
Non-Home Based Work					
Walk/Bike	0.4	0.6	2	0.6	2
Auto	98.8	98.5	96.1	98.5	96.1
Transit	0.8	0.9	1.9	0.9	1.9
Non-Home Based Non-Work					
Walk/Bike	0.3	0.4	0.8	0.4	0.8
Auto	99	98.9	97.9	98.9	97.9
Transit	0.7	0.7	1.3	0.7	1.3
Total Non-Home Based					
Walk/Bike	0.3	0.5	1.2	0.5	1.2
Auto	98.9	98.8	97.2	98.8	97.2
Transit	0.7	0.8	1.5	0.8	1.5
Total All Trips					
Walk/Bike	3.8	4.5	5.7	4.5	5.7
Auto	89.1	87.6	85.8	87	84.5
Transit	7	8	8.5	8.6	9.8

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Table 2-4: Mode Choice Adjusted to Compensate for Walk/Bike Under-Reporting (by percentage of trips)

	No Build	LUTRAQ	Adjusted LUTRAQ	LUTRAQ (TOD Only)	Adjusted LUTRAQ (TOD Only)	LUTRAQ/ Congestion Pricing	Adjusted LUTRAQ/ Congestion Pricing	LUTRAQ/ Congestion Pricing (TOD Only)	Adjusted LUTRAQ/ Congestion Pricing (TOD Only)
Home Based Trips									
Home Based Work									
Walk/Bike	2.8	3.5	4.6	5	6.1	4	5.1	5.7	6.8
Auto	89.7	78.3	77.4	66.7	66	74.9	74.1	62.1	61.4
SOV	75.8	58.2	57.5	49.6	49	55.3	54.6	45.7	45.2
Carpool	14	20.1	19.9	17.2	17	19.6	19.4	16.4	16.2
Transit	7.5	18.2	18	28.2	27.9	21.1	20.8	32.1	31.8
Home Based Non-Work									
Home Based Other									
Walk/Bike	3.3	3.9	9.3	6	12.8	4.4	9.8	7	13.8
Auto	95.6	94	88.7	90	83.5	93.3	88	88.9	82.4
Transit	1.1	2.1	2	4	3.7	2.3	2.2	4.2	3.9
Home Based School									
Walk/Bike	19.4	19.4	26.1	19.4	42.7	19.4	26.1	19.4	42.7
Auto	29.6	29.6	27.2	29.6	21.2	29.6	27.2	29.6	21.2
Transit/School Bus	51	51	46.7	51	36.1	51	46.7	51	36.1
Home Based College									
Walk/Bike	3.2	6	6	4.3	4.8	7.1	7.1	4.8	7.1
Auto	80.9	78.4	78.4	77.4	77.4	77.8	77.8	76.3	76.3
Transit	15.9	17.3	17.3	16.6	16.6	17.4	17.4	16.6	16.6
Total Home Based Non-Work									
Walk/Bike	6	6.5	11.8	9.9	20.7	6.9	12.2	10.4	20.8
Auto	84	82.6	78.5	71.1	65.5	82	77.9	71.8	66.1
Transit	10	10.9	9.7	18.9	13.8	11.1	9.9	17.9	13.1
Total Home Based									
Walk/Bike	5.1	5.6	9.9	8.7	17.2	6.1	10.3	9.2	17.4
Auto	85.6	81.4	78.2	70.1	65.6	80	76.9	69.3	64.9
Transit	9.3	12.9	12	21.2	17.2	13.9	12.9	21.5	17.7
Non-Home Based Trips									
Non-Home Based Work									
Walk/Bike	0.4	0.9	7.8	1.7	13.1	1.1	10	2	15.9
Auto	98.9	98.1	91.3	96.5	85.4	97.7	89	96.2	82.5
Transit	0.7	1	1	1.8	1.6	1.1	1	1.8	1.6
Non-Home Based Non-Work									
Walk/Bike	0.3	0.5	3.2	0.9	10.2	0.7	4.5	0.9	9.6
Auto	99.1	98.7	96.1	98	88.8	98.5	94.6	97.9	89.3
Transit	0.6	0.7	0.7	1.1	1	0.9	0.8	1.2	1.1
Total Non-Home Based									
Walk/Bike	0.3	0.7	4.8	1.2	11.4	0.8	6.6	1.4	12.3
Auto	99	98.5	94.4	97.4	87.3	98.2	92.5	97.1	86.4
Transit	0.6	0.8	0.8	1.4	1.3	1	0.9	1.5	1.3
Total All Trips									
Walk/Bike	3.8	4.3	8.5	6.8	15.6	4.7	9.3	6.9	15.8
Auto	89.1	86	82.5	77.2	71.6	84.8	81	77.4	71.5
Transit	7	9.7	9	16	12.8	10.5	9.7	15.7	12.7

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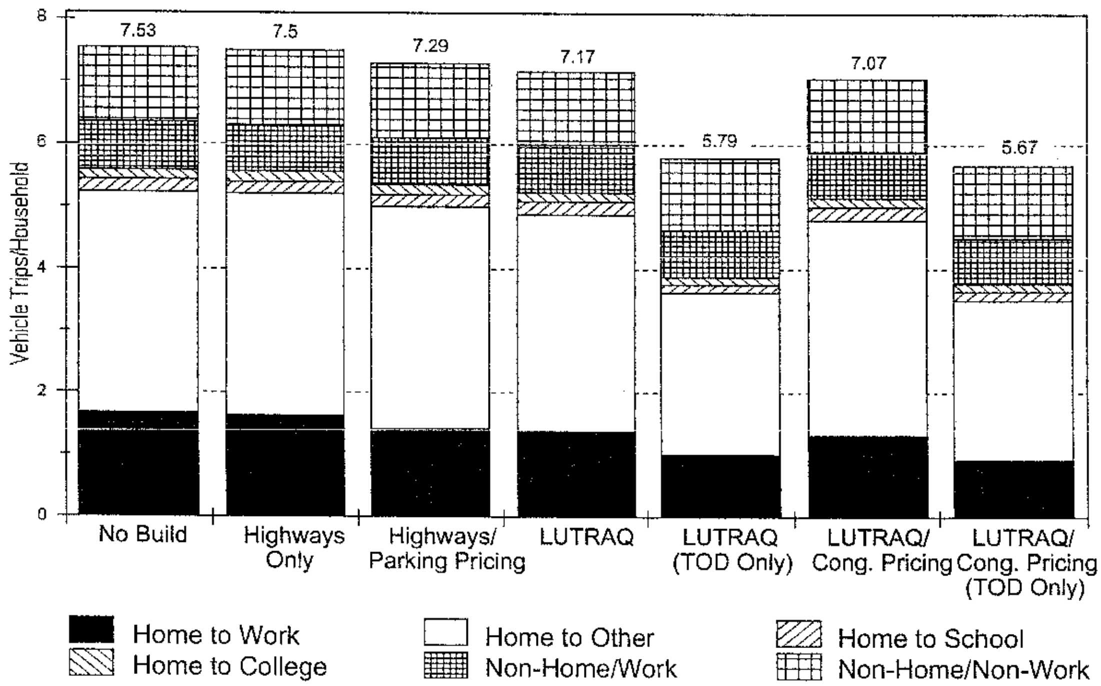
Vehicle Trips Per Household

The shift of work trips to non-auto modes for the LUTRAQ alternatives translates into fewer vehicle trips per household, as shown in Table 2-5 and Figure 2-4.

Table 2-5: Vehicle Trips per Household

	No Build	Highways Only	Highways/ Parking Pricing	LUTRAQ	LUTRAQ (TOD Only)	LUTRAQ/ Congestion Pricing	LUTRAQ/ Congestion Pricing (TOD Only)
HOME BASED TRIPS							
Work	1.67	1.63	1.42	1.38	1	1.32	0.92
Other	3.56	3.57	3.57	3.5	2.62	3.47	2.59
School	0.2	0.2	0.2	0.2	0.13	0.2	0.13
College	0.16	0.16	0.16	0.16	0.13	0.16	0.13
Total Home Based	5.59	5.56	5.35	5.24	3.88	5.15	3.77
NON-HOME BASED TRIPS							
Work	0.76	0.76	0.76	0.75	0.74	0.75	0.74
Non-work	1.18	1.18	1.18	1.17	1.17	1.17	1.16
Total Non-Home Based	1.94	1.94	1.94	1.93	1.91	1.92	1.9
TOTAL TRIPS	7.53	7.5	7.29	7.17	5.79	7.07	5.67

Figure 2-4: Vehicle Trips per Household



The number of vehicle trips per household would decrease by 5 percent with the LUTRAQ alternative, compared to the No Build or Highways Only alternatives. Most of the changes are in trips to and from work. Within the TOD areas, vehicle trips per household are 25 percent lower for LUTRAQ and 32 percent lower for LUTRAQ/Congestion Pricing than in the study area for the other alternatives. This is likely because residents of TODs make a larger percentage of trips by walking, biking, and transit for both work and other purposes like shopping and recreation, and because their household characteristics dispose them to use autos less.[2]

Vehicle Hours of Delay

All of the alternatives reduce congestion, as measured in vehicle hours of delay, over the No Build alternative. As Table 2-6 and Figure 2-5 show, the LUTRAQ alternative reduces congestion 53.2 percent, 10 percentage points more than the Highways Only alternative. The LUTRAQ/Congestion Pricing alternative has an even greater impact because of the per mile charge for work trips, which occurs at the most congested times of day.

Table 2-6: Vehicle Hours of Delay (P.M. Peak Hour)

	No Build	Highways Only		Highways/Parking Pricing		LUTRAQ		LUTRAQ/ Congestion Pricing	
	VHD	VHD	Difference[1]	VHD	Difference	VHD	Difference	VHD	Difference
Freeways	1140	470	-58.8%	370	-67.5%	390	-65.8%	200	-82.5%
Principal/Major Arterials	960	660	-31.3%	470	-51%	520	-45.8%	430	-55.2%
Minor/Other Arterials	830	540	-34.9%	370	-55.4%	460	-44.6%	370	-55.4%
Total All Classes	2930	1670	-43%	1210	-58.7%	1370	-53.2%	1000	-65.9%

1. Compared to the No Build alternative.

This is the only measure of transportation behavior on which a highway alternative performs better than the LUTRAQ alternative. The Highway/Parking Pricing alternative has 160 hours, or 12 percent, fewer hours of delay than the LUTRAQ alternative. The combination of expanded highway capacity and reduced demand, especially for work trips, reduces congestion. Enhanced highway capacity (as seen in Highways Only) reduces delay by 1,260 hours or 43 percent compared to the No Build alternative. Adding parking charges and free transit passes reduces hours of delay another 300 hours, or an additional 10 percent. The LUTRAQ alternative contains the same demand management program as the Highway/Parking Pricing alternative, but does not add nearly as much highway capacity. Although a number of people shift to non-automotive modes, this is not enough to reduce congestion to the levels of the Highway/Parking Pricing alternative.

2. N.B.: The LUTRAQ alternative assumes household characteristics in 2010 that are consistent with the continuation of current economic, social, and political trends. If these trends were to vary dramatically during the study period, significant shifts in housing choices and travel behavior would be expected. For example, if household income growth were to stagnate, or if current financial incentives for home ownership were trimmed, one would expect to see a stronger multi-family housing market, and a wider range of household types choosing multi-family housing products, than was assumed for the LUTRAQ alternative.

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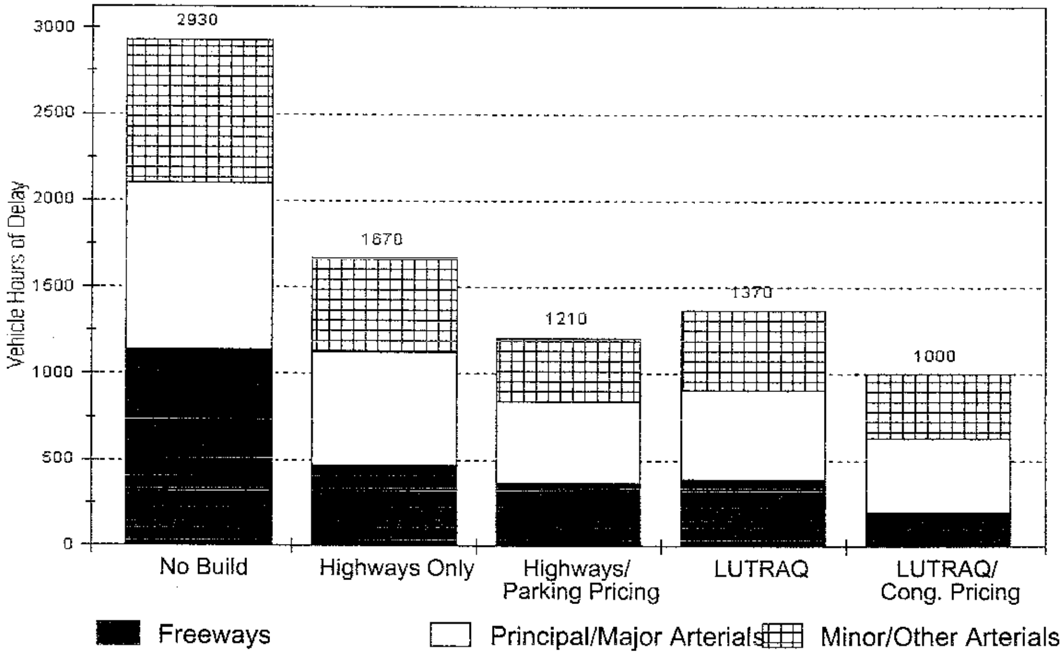
Figure 2-5: Vehicle Hours of Delay (P.M. Peak Hour)



The higher speeds of the Highway/Parking Pricing alternative may, however, be only a temporary phenomena. The Standing Advisory Committee on Trunk Road Assessment of Great Britain[3] surveyed the evidence on whether road capacity influences the amount of traffic. They concluded "that about half the time saved through speed increases might be used for additional travel. We interpret this as a short-term effect. The longer-term effect is likely to be greater, with a higher proportion (perhaps all) of the time saved being used for further travel (p. 47)."

The LUTRAQ alternative puts more emphasis on transit improvements and changing the environment around transit than on highways. The result is slightly higher levels of vehicle delay in exchange for much higher rates of transit ridership and walk/bike travel and lower levels of vehicle miles of travel.

Also balanced against LUTRAQ's higher congestion levels is the substantially greater degree of accessibility to jobs afforded by the LUTRAQ alternative. Under LUTRAQ, the percentage of the study area within 30 minutes travel of 500,000 jobs is 67.5%, a 25.8% increase over the No Build alternative. By contrast, only 55.7% of the area would have the same degree of access under the Highways Only alternative (a 13.9% increase over the No Build alternative). In other words, the LUTRAQ alternative trades a slight decrease in mobility (as measured by vehicle hours of delay) for a substantial increase in accessibility. *See* Table 2-7.

3. Standing Advisory Committee on Trunk Road Assessment, *Trunk Roads and the Generation of Traffic* (London: HMSO, 1994).

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Table 2-7: Accessibility to Population, Jobs, and Shopping

	No Build	Highways/Parking Pricing		LUTRAQ	
			Difference[1]		Difference
% of Study Area w/i 30 Mins. of 800,000 Population	40.7	70.6	23.9%	64.4	23.7%
% of Study Area w/i 30 Mins. of 500,000 Jobs	41.8	55.7	13.9%	67.5	25.8%
% of Study Area w/i 15 Mins of 25,000 Retail Jobs	74.2	78.9	4.6%	78.1	3.9%

1. Compared to the No Build alternative.

Adding peak period pricing to the LUTRAQ/Congestion Pricing alternative shifts a larger number of commuters from driving to other modes. This reduces the amount of delay during rush hour by 210 hours from the Highway/Parking Pricing level.[4] Compared to the No Build alternative, the LUTRAQ/Congestion Pricing alternative would reduce vehicle hours of delay by 83 percent on freeways and 55 percent on all types of arterials. Compared to the Highway/Parking Pricing alternative, the LUTRAQ/Congestion Pricing alternative has 46 percent fewer hours of delay on freeways, and 9 percent fewer on primary and minor arterials.

Peak Vehicle Hours of Travel and Daily Miles of Travel

All of the alternatives would reduce peak period vehicle hours of travel within the study area over the No Build alternative. The improved speeds on highways, however, would result in increased vehicle miles of travel in the Highways Only alternative. The LUTRAQ alternative would reduce both vehicle hours and vehicle miles of travel.

Table 2-8 shows the changes in vehicle hours of travel. The Highways Only alternative would improve speeds on freeways resulting in fewer hours of travel in the peak period, but it would increase travel hours on principal/major arterials. The alternative includes many improvements to principal arterials, and this enhanced capacity would result in greater use of these routes. The transit oriented development pattern of the LUTRAQ alternatives would reduce travel times on all types of facilities. With the LUTRAQ alternative, overall vehicle use would decline by about 16 percent compared to the No Build alternative with the greatest improvements on the more local streets, followed by principal arterials, and then freeways. Adding congestion pricing would reduce vehicle hours further on all types of facilities, but especially on freeways.

Table 2-8: Vehicle Hours of Travel (P.M. Peak Hour)

	No Build	Highways Only		Highways/Parking Pricing		LUTRAQ		LUTRAQ/ Congestion Pricing	
	VHT	VHT	Difference[1]	VHT	Difference	VHT	Difference	VHT	Difference

4. Some trips would probably shift to other times of day when there would be no charge, but the Metro model, in its current form, cannot consider this change in behavior.

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Table 2-8: Vehicle Hours of Travel (P.M. Peak Hour)

Freeways	6,270	5,900	-5.9%	5,610	-10.5%	5,590	-10.8%	4,930	-21.4%
Principal/Major Arterials	6,220	6,890	10.8%	6,250	0.5%	5,360	-13.8%	4,990	-19.8%
Minor/Other Arterials	8,620	7,130	-17.3%	6,380	-26%	6,840	-20.6%	6,230	-27.7%
Total All Classes	21,110	19,920	-5.6%	18,240	-13.6%	17,790	-15.7%	16,150	-23.5%

1. Compared to the No Build alternative.

Table 2-9 shows the estimated daily vehicle miles of travel for each alternative. The Highways Only alternative demonstrates that building additional highway capacity without programs to reduce demand, would increase the total miles of vehicle travel in the region even though the hours of travel decline. The LUTRAQ alternative would reduce the amount of vehicle travel by shifting more trips to non-automotive modes. The transit oriented development pattern of the LUTRAQ alternative reduces vehicle miles of travel in the study area by about 6 percent compared to the No Build alternative. Adding peak hour pricing to this alternative more than doubles the reduction in vehicle miles of travel to 13 percent.

Table 2-9: Daily Vehicle Miles Traveled

No Build	Highways Only		Highways/Parking Pricing		LUTRAQ		LUTRAQ/Congesition Pricing	
VMT	VMT	Difference[1]	VMT	Difference	VMT	Difference	VMT	Difference
6,883,955	6,995,986	1.6%	6,856,447	-0.4%	6,442,348	-6.4%	5,976,191	-13.2%

1. Compared to the No Build alternative.

Air Quality - Carbon Monoxide and Ozone Precursors

Changes in travel behavior also produce changes in the emissions of pollutants. As Table 2-10 shows, the LUTRAQ alternative would reduce emissions for all three types of pollutants—hydrocarbons (HC), nitrogen oxides (NOx), and carbon monoxide (CO). Reductions in congestion and delay times generally reduce emissions, but NOx emissions increase with higher average speeds, and speeds would increase with the highway alternatives, as previously discussed. Table 2-10 shows that for the Highways Only alternative, NOx emissions would increase by almost 7 percent, while reductions in HC and CO would be negligible. In contrast, the LUTRAQ alternative reduces NOx by three percent and HC and CO by 6.2 percent and 6.7 percent respectively. Because the LUTRAQ/Congestion Pricing alternative would induce more shifts to non-motorized means of travel than the LUTRAQ alternative, it reduces pollutants the most. The LUTRAQ/Congestion Pricing alternative is more effective because it not only shifts people to other modes, but it

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also reduces congestion so that traffic moves more smoothly.

Table 2-10: Air Pollutant Emissions (kg/day)

	No Build	Highways Only		Highways/Parking Pricing		LUTRAQ		LUTRAQ/Congesition Pricing	
			Difference[1]		Difference		Difference		Difference
HC	9,988	9,965	-0.2%	9,626	-3.6%	9,366	-6.2%	8,840	-11.5%
NO_x	14,104	15,054	6.7%	14,620	3.6%	13,744	-2.6%	12,914	-8.4%
CO	94,605	94,057	-0.6%	90,813	-4%	88,262	-6.7%	83,296	-12%

1. Compared to the No Build alternative.

Green House Gases and Energy Consumption

The estimates of greenhouse gas emissions and energy consumption are directly related to the differences in vehicle miles of travel with each alternative. Table 2-11 shows that, compared to the No Build alternative, the Highways Only alternative increases emissions of methane (CH_4), nitrous oxide (N_2O), and carbon dioxide (CO_2), and energy consumption by about 1.6 percent. In contrast, the LUTRAQ and LUTRAQ/Congestion Pricing alternatives reduce emissions and energy consumption by 6.4 and 13.2 percent, respectively. The LUTRAQ/Congestion Pricing alternative has the greater impact because the charge for work trips reinforces the other measures that reduce travel.

Table 2-11: Greenhouse Gas Emissions (kg/day) & Energy Consumption (millions of BTUs)

	No Build	Highways Only		Highways/Parking Pricing		LUTRAQ		LUTRAQ/Congesition Pricing	
			Difference[1]		Difference		Difference		Difference
CH_4	786	799	1.6%	783	-0.4%	736	-6.4%	683	-13.2%
N_20	526	534	1.6%	524	-0.4%	492	-6.4%	457	-13.2%
CO_2	4,814,705	4,893,061	1.6%	4,795,466	-0.4%	4,505,841	-6.4%	4,179,806	-13.2%
Energy Consumption	35,089	35,660	1.6%	34,949	-0.4%	32,838	-6.4%	30,462	-13.2

1. Compared to the No Build alternative.

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Conclusion

The data presented here clearly indicate that building highways does not solve suburban transportation problems. Compared to other build options, such a "solution" in the LUTRAQ study area would result in increased driving, low transit ridership, dirtier air, more greenhouse gases, and higher energy consumption. In contrast, a combined approach of reorganizing land uses, providing high quality transit service, and instituting demand management measures provides an effective short-term and long-term suburban transportation strategy. For the LUTRAQ study area, implementation of these policies would lead to substantially lower dependence on the automobile, higher transit ridership, cleaner air, lower greenhouse gas emissions, and less energy consumption.

Although the LUTRAQ alternative represents a marked shift from the status quo, it does not attempt to modify urban design patterns in the entire study area, but only in selected neighborhoods near transit lines. The alternative's assumptions for the composition and mix of building types for development are also constrained by a market demand forecast that assumes the housing preferences of recent decades for different demographic segments will persist into the future. This implies continued tax subsidies for housing and automobile transportation, rising real household incomes, and continued high levels of consumer and public debt to finance housing and transportation consumption. In addition, despite experience in cities such as Davis, California and Copenhagen, Denmark showing that the development of comprehensive cycling networks can have a profound effect in diverting car trips to the bicycle and to transit, such improvements were not included in the alternative because the model used to evaluate the alternative was unable to quantify them.

Notwithstanding these limitations, the analysis presented in this volume demonstrates that transit and pedestrian oriented urban design and infill development, and the retrofit of pedestrian improvements to automobile-oriented suburbs, can have significant effects on travel behavior sufficient to eliminate the need to build new ring freeways, particularly when reinforced by sensible economic and pricing incentives, such as modest parking charges and reduced transit fares that begin to level the playing field between travel modes. One would expect even greater effects on travel behavior when these measures are combined with bicycle improvements, stronger economic incentives, more effective parking management, introduction of neighborhood vehicles, and further shifts in land use policies to favor infill housing and commercial development.

PREFACE

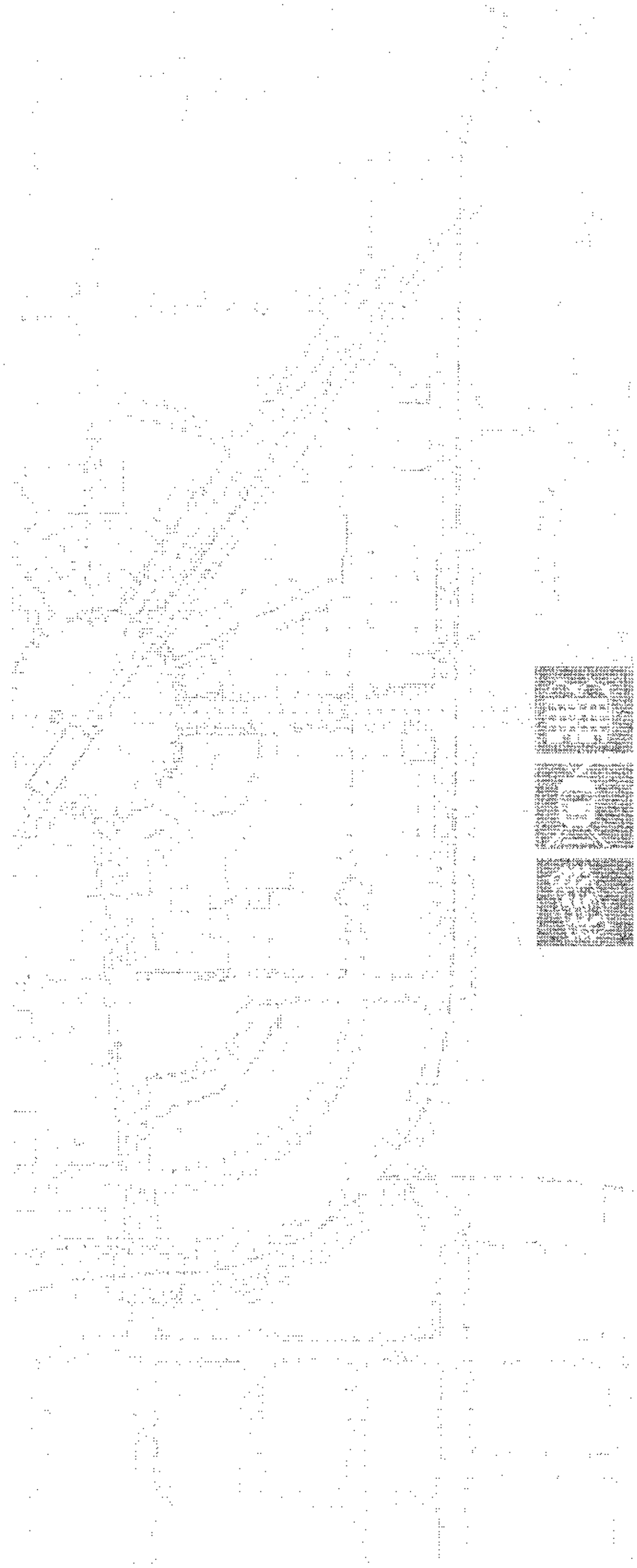
In 1988, a new land-use and transportation alternative and an innovative research program began to take shape in metropolitan Portland, Oregon. What started with opposition to the proposed Western Bypass suburban freeway, evolved into the project this report reviews, Making the Land Use, Transportation, Air Quality Connection (LUTRAQ).

Spearheaded by 1000 Friends of Oregon, a public interest group that monitors land-use planning across Oregon, the LUTRAQ project was created to challenge auto-based transportation projects and auto-dependent development patterns. With funding from the Federal Highway Administration, the Environmental Protection Agency, The Energy Foundation, and others, the project ultimately achieved its primary objective: to influence policymakers to replace the proposed bypass with an alternative that emphasizes transit improvements and complementary changes in land-use policy.

Between 1991 and 1997, LUTRAQ produced 11 technical reports on topics including integrated land-use and transportation modeling, urban design, and market feasibility of transit-oriented development. The project created an alternative land-use and transportation plan for Washington County (the project's study area), published research on the impacts of pedestrian-friendly design, and produced a set of design and zoning guidelines for transit-oriented development.

It is the project's secondary objective – to promote development patterns that reduce land consumption, vehicle trips, and air pollution nationwide – that is the mission of this report. As traffic congestion presses in on metropolitan areas across the country, more and more communities are searching for solutions. The lessons of the LUTRAQ project, gleaned from years of research, analysis, and grassroots involvement, are as relevant in Portland, Maine, as they are in Portland, Oregon.

This booklet reviews the history and key findings of the LUTRAQ project in the Portland area and gives examples of how other cities are addressing similar problems. It is intended to provide citizens, policymakers, and planners with a summary of the process, methods, and findings from the project without elaborating on technical details. Information about the methods and models used in the project may be found in the following technical reports:



Vol. 1, Modeling Practices, 1991.

Vol. 2, Existing Conditions, 1991.

Vol. 3, The LUTRAQ Alternative, 1992.

Vol. 3A, Market Research, 1992.

Vol. 4, Model Modifications, 1996.

Vol. 4A, The Pedestrian Environment, 1993.

Vol. 4B, Building Orientation, 1994.

Vol. 5, Analysis of Alternatives, 1996.

Vol. 6, Implementation, 1995.

Vol. 8, Making the Connections: Technical Report, 1997.

Site Design and Travel Behavior: A Bibliography, 1993.

This booklet is organized into three sections. The first section describes the problems the LUTRAQ project sought to address: dispersed land-use patterns that encourage auto use and reliance on new highway capacity to relieve congestion. The second section reviews the project's technical and political processes, focusing on three key factors in developing integrated land-use and transportation solutions: land-use plans and design standards, transportation investments, and market strategies. The section addresses several topics associated with LUTRAQ, including the design of transit-oriented development and the impact of the pedestrian environment on travel choices. The final section makes the connection between LUTRAQ and similar projects in North America.

We hope this booklet will help you "make the connections," too, as you work to build better communities in your region.

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Chapter 1: Description of Alternatives

The analyses discussed in this report compare the behavioral consequences of five primary alternatives. All of the alternatives assign the same number of households and jobs to the study area. None of the alternatives contain changes in the metropolitan urban growth boundary. The non-LUTRAQ alternatives assume that development will occur as planned in current comprehensive plans. These plans place much of the expected growth in households and jobs at the edge of the region, near the urban growth boundary and away from existing or proposed transit service. The LUTRAQ alternative reconfigures future growth to a pattern that reinforces the planned transit system. Net density in Washington County is not significantly altered under the LUTRAQ alternative. Instead, planned moderate and high density residential development is shifted to locations that are better served by transit.

Figure 1-1: LUTRAQ Project Study Area*

* With the exception of the outlying communities of Forest Grove/Cornelius and Wilsonville, the study area for the LUTRAQ project includes all of the land inside the urban growth boundary in Washington County.

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A fundamental premise of the LUTRAQ alternative is to work within current real estate market trends and expectations. Thus, the alternative proposes residential densities, employment, and shopping opportunities that, given current market practices, could be built in the foreseeable future. In some cases residential product types are not presently used in Washington County, but recent demographic and regional price trends indicate viable near term demand.[1]

The five primary alternatives studied in this report are:

The No Build alternative. This is the base case of present conditions and transportation projects for which full funding had been committed by 1988. This includes building one new light rail line part way into the county (Westside Light Rail to 185th Avenue).

The Highways Only alternative. This alternative is a supply side solution to future congestion that emphasizes the construction of highway, street, and intersection improvements, and some expansions to transit service. The alternative includes the construction of a new four-lane, limited access highway, commonly called the Western Bypass, between Interstate 5 and Highway 26, from Tualatin to Hillsboro. *See* Figure 1-2. Highway 217 is expanded to three general purpose lanes in each direction with preferential treatment for high occupancy vehicles and transit. Also included are a series of roadway expansions that are currently included in existing jurisdictional and agency plans but not funded as of 1988. Transit improvements include extension of Westside Light Rail from 185th to downtown Hillsboro, expanded feeder bus service for the light rail, and express bus service on Highway 217 with feeder routes.

The Highway/Parking Pricing alternative. This is the Highways Only alternative plus parking pricing, subsidized transit passes, and demand responsive transit. The parking charge equals one-third the cost of parking in downtown Portland, about $3.00 per day, and applies only to persons who commute to work in the study area by driving alone. In other words, there is no charge for people who carpool (2 more/car) to work or who make trips for non-work purposes. The income from the parking charges subsidizes the transit pass program, which provides a free pass to all people working in the study area. The demand responsive transit program provides transit service to riders when and where it is needed in areas not served by fixed-route transit. It includes types of dial-a-ride, shared ride, and shuttle services.

The LUTRAQ alternative. This alternative rearranges the assignments of new households and jobs in the study area. The majority of new development (65 percent of expected residential units and 78 percent of future jobs) is located in transit oriented developments (TODs). The TODs cluster jobs, residences, and shopping near transit lines to encourage transit use. Three types of TOD concepts are used. Mixed Use Centers are located in each community, with the largest center in Beaverton, and less intensive centers in Hillsboro, the Washington Square area of Tigard, the Barbur Boulevard/Highway 217/ Interstate 5 triangle, downtown Tualatin, and downtown Sherwood. Urban TODs are located outside of Mixed Use Centers, primarily along light rail alignments, and include medium to high density housing and a commercial core area. Neighborhood TODs

1. *See* 1000 Friends of Oregon, *Making the Land Use, Transportation, Air Quality Connection*, Vol. 3A, *Market Research* (Portland, Oregon, 1992).

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Figure 1-2: The Highways Only Alternative

Figure 1-3: The LUTRAQ Alternative

include medium density housing and convenience shopping facilities.

Transit improvements in the alternative include the extension of Westside light rail to downtown Hillsboro and additional light rail lines along Highway 217, Barbur Boulevard, and Highway 43, with an extension to Tigard and Tualatin. Local feeder and express bus services support the expanded light rail system. This alternative also includes the parking pricing and transit pass programs and the demand responsive transit services included in the Highway/Parking Pricing alternative. In addition, the LUTRAQ alternative incorporates sidewalks and bikeways and traffic-control measures to allow safe crossings for pedestrians and bicyclists in all light rail corridors. This improves pedestrian and bicyclist access to transit throughout the study area. Selected roadway improvements include widening portions of Highway 99W, Highway 217, Highway 26, Farmington Road, Tualatin Road, Gaarde Street and intersection improvements on the Tualatin Valley Highway. *See* Figure 1-3.[2]

The LUTRAQ/Congestion Pricing alternative. This is the LUTRAQ alternative plus a $0.15 per mile work trip charge for automobile trips. This adds peak period or congestion pricing to the land use/demand management/transportation package in the LUTRAQ alternative. In addition, the alternative includes more street crossing and sidewalk improvements in bus corridors with frequent service. Also more growth is concentrated in the Mixed Use Center TODs. About 4,700 study area households and 3,300 study area jobs are reassigned from areas outside TODs to Mixed Use Centers. This boosts the proportion of study area households in TODs from 8.4 to 9.0 percent. Likewise, the proportion of study area jobs in TODs increases from 10.3 to 10.6 percent.

Table 1-1 summarizes the alternatives.[3]

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2. For more information about the LUTRAQ alternative, see ibid., Vol. 3, *The LUTRAQ Alternative* (1992).

3. The No Build, Highway/Parking Pricing, and LUTRAQ alternatives are the same as alternatives included in a Major Investment Study analysis of the Western Bypass conducted by the Oregon Department of Transportation. The No Build and LUTRAQ alternatives have the same names in that report and the Highway/Parking Pricing alternative is known as the Western Bypass alternative. *See* Oregon Department of Transportation, *Western Bypass Study Alternatives Analysis* (Portland, Oregon, 1995). The Highways Only and LUTRAQ/Congestion Pricing alternatives were not included in that study, but are included in this report to test a fuller range of options for solving transportation problems.

Table 1-1: Description of Alternatives

	No Build	Highways Only	Highways/ Parking Pricing	LUTRAQ	LUTRAQ/ Congestion Pricing
Land Use	Existing plans	Existing plans	Existing plans	Transit-oriented development	Same as "LUTRAQ"
Transit	Westside LRT to 185th w/ feeder buses	"No Build" + LRT to Hillsboro; express bus on Hwy 217	"Highways Only" + demand responsive transit	"Highways/Parking Pricing" + LRT on Hwy 217, Barbur Blvd & Hwy 43; express bus to Forest Grove, Sherwood, Bethany & Scholls Ferry	Same as "LUTRAQ"
Roads	Only fully funded projects	Western Bypass & 48 other improvements	Same as "Highways Only"	Selected improvements; no Bypass	Same as "LUTRAQ"
Walk/Bike Facilities	Existing	Existing	Existing	Existing + improvements in transit oriented developments & LRT corridors	Same as "LUTRAQ" + improvements in bus corridors
Demand Management	None	None	Parking charges/ transit passes for workers	Same as "Highways/ Parking Pricing"	Same as "LUTRAQ"
Road Pricing	None	None	None	None	Peak period charge of $0.15/ mile for work trips

The main emphasis of this report is a comparison of the LUTRAQ alternative with the No Build and Highways Only alternatives. In other words, the report highlights the differences between continuing with current conditions, building numerous roadway improvements, and changing land uses to facilitate transit use and supporting those changes with pricing policies and transportation improvements. Results for Highway/Parking Pricing and LUTRAQ/Congestion Pricing are also presented in most of the tables and are discussed when they differ significantly from other alternatives.

In addition, two other alternatives—LUTRAQ/No Pricing and LUTRAQ/Parking Pricing—are also discussed to show the relative impact of the several elements in the LUTRAQ alternatives, and to underscore the importance of pursuing a "package approach" with a number of complementary actions, rather than single facilities or policies.

The LUTRAQ/No Pricing alternative. Only the transit-oriented land use plan and new light rail lines are included in this alternative. No other elements of the LUTRAQ alternative are included.

The LUTRAQ/Parking Pricing alternative. This alternative adds to the previous alternative the $3.00 parking charge/free transit pass package discussed in other alternatives. This alternative, however, does not include the demand responsive transit, selected highway improvements, or enhancement of the pedestrian environment included in the LUTRAQ alternative.

These last two alternatives were modeled using a different study area, and, hence, cannot be directly compared with the five primary alternatives.[4]

The alternatives studied in this report are designed to compare, contrast, and combine three elements of congestion management programs: enhancements to transportation infrastructure; land use development policies to support walking, bicycling, and transit use; and demand management policies—including pricing of parking and peak period road use—to reduce automobile use. The simulations were conducted on Metro's modeling system, as enhanced by the LUTRAQ consulting team. The enhancements introduce new variables into the models that increase their sensitivity to the role that land use plays in affecting auto ownership, mode choice, and destination choice.[5]

4. Because of the differences in study areas, the LUTRAQ/No Pricing and LUTRAQ/Parking Pricing alternatives contain 4.5% more households and .5% fewer jobs than the five primary alternatives. These differences significantly affect daily vehicle miles of travel and other composite measures, making comparisons across all seven alternatives impossible.

5. For more information about the LUTRAQ model enhancements, see Appendix A of this report and Vol. 4, *Model Modifications*.

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Summary

LUTRAQ and Volume 5: Analysis of Alternatives

Making the Land Use, Transportation, Air Quality Connection (LUTRAQ) is a national demonstration project to develop alternative suburban land use patterns and design standards, and to evaluate their impacts on automobile dependency, mobility, air quality, and energy consumption.

Using the proposed Western Bypass freeway around the Portland, Oregon metropolitan region as a case study, the LUTRAQ project has, to date, successfully identified alternative land use patterns that have significantly less than average reliance on the automobile, and developed transportation modeling procedures to forecast travel behavior associated with these land use patterns.

This report outlines the likely transportation, air quality, greenhouse gas, and energy impacts of various alternative future scenarios for the urbanized portion of Washington County, Oregon. These scenarios, which are described in Chapter 1, include the LUTRAQ alternative. This alternative changes the existing land use plans in the county to focus future development around transit stations in a mixed use, pedestrian friendly environment. The alternative also includes a complementary package of transit improvements, pedestrian improvements in transit corridors, parking charges, and selected highway improvements. Another alternative, known as the LUTRAQ/Congestion Pricing alternative, adds peak hour pricing to this land use, transit, parking policy mix. Other alternatives include two highway building alternatives, one that focuses on freeway/roadway construction, and another that includes parking charges.

Chapter 2 analyzes the travel behavior, air quality, greenhouse gas, and energy outcomes associated with each alternative in the year 2010. The analysis was done using the travel forecasting and air quality models of Metro (the Portland area regional government) as modified for the LUTRAQ project.[1] Greenhouse gas effects and energy consumption were modeled using Metro's traffic parameters and procedures from EPA's *State Workbook: Methodologies for Estimating Greenhouse Gas Emissions* and *Transportation Energy Data Book: Edition 14*. See Appendix A for further discussion of methodology.

Key Conclusions

Building highways does not solve suburban transportation problems. According to the analyses, constructing the improvements associated with a highway intensive alternative (i.e., the Highways Only alternative) would result in:

- the highest rates of single occupancy vehicle use of any of the "build" alternatives surveyed (i.e., all but the No Build alternative);
- the lowest rates of transit use for work trips of any build alternative;
- the most congestion (measured in vehicle hours of delay) of any build

1. For information on the modifications made to Metro's models, see 1000 Friends of Oregon, *Making the Land Use, Transportation, Air Quality Connection,* Vol. 4, *Model Modifications* (Portland, Oregon, 1996).

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alternative;

- the most vehicle hours of travel in peak periods of any build alternative;
- the most vehicle miles of travel per day of any alternative;
- significant increases in nitrogen oxide emissions and negligible reductions in hydrocarbon and carbon monoxide emissions; and
- substantial increases in greenhouse gas emissions and energy consumption.

Some of the effects of highway building can be moderated by adding transit improvements and demand management programs that include parking pricing. The Highways/Parking Pricing alternative, which includes these programs, doubles carpooling and boosts transit use 1.5 times compared to the Highways Only alternative. This shift in peak period mode of travel reduces vehicle hours of delay significantly. These efforts to manage highway use, however, have quite modest impacts on the number of vehicle trips per day, vehicle miles of travel, vehicle emissions, and energy use.

In contrast, the LUTRAQ alternative reduces vehicle travel, congestion, emissions, and energy use. If constructed, the LUTRAQ alternative would likely result in:

- auto ownership rates 5 percent lower than in the No Build alternative;
- fewer work trips by single occupancy vehicle than in the No Build alternative (58 percent compared to 76 percent for the No Build alternative);
- more than twice as many work trips by transit as the Highways Only and No Build alternatives;
- fewer vehicle trips per household each day (7.17 compared to 7.53 for the No Build alternative);
- less peak hour traffic delay than the No Build or Highways Only alternatives;
- fewer vehicle miles of travel than the No Build or the highways alternatives (7.9% fewer than the Highways Only alternative);
- fewer peak hour vehicle hours of travel (10.7% fewer than the Highways Only alternative);
- reductions in nitrogen oxide, hydrocarbons, and carbon monoxide emissions of 2.6 to 6.7 percent compared to the No Build alternative; and
- reductions in greenhouse gas emissions and energy consumption of about 6.4 percent compared, again, to the No Build alternative.

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Adding congestion pricing to this package shifts more work trips to walk/bike and transit modes. The resulting reduction in peak period traffic further decreases congestion, vehicle miles of travel, emissions, and energy use.

The transit oriented developments (TODs) contribute substantially to the results achieved by the LUTRAQ alternative. In 2010, residents of TODs would enjoy the following advantages:

- about 35 percent of TOD households would choose to own only one car, and 9 percent would own none;
- nearly 30 percent of residents would travel to work by transit;
- TOD residents would be twice as likely to walk to work as residents of the study area in the Highways Only alternative;
- children in TODs would be twice as likely to walk or bike to school as children in the study area in the Highways Only alternative; and
- TOD households would need to make about 1.7 fewer car trips per day than households in the study area in the Highways Only alternative.

In sum, the analysis of the alternatives demonstrates that transit and pedestrian oriented urban design and infill development, and the retrofit of pedestrian improvements to automobile-oriented suburbs, can have significant effects on travel behavior sufficient to eliminate the need to build new ring freeways, particularly when reinforced by sensible economic and pricing incentives, such as modest parking charges and reduced transit fares that begin to level the playing field between travel modes.

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THE CHALLENGE OF GROWTH

Driven To Crisis

The high price of suburban sprawl

Metropolitan areas across the United States are facing problems fueled by decades of suburban sprawl and heavy dependence on the automobile: traffic congestion, long commutes, loss of natural resource land, vanishing open spaces, air and water pollution, neighborhood and inner city deterioration, and the rising cost of public services.

Demand for land and mobility continue to increase, driven by many factors, including population, household, and employment growth in metropolitan areas, rising income, and stable fuel prices. At the same time, governments are facing the fact that they can no longer provide the highways and other public services that new development requires at the quantity, quality, and price citizens now expect.

Congestion is worsening in most metropolitan areas. A recent study shows that between 1986 and 1990, total hours of delay increased in 39 of the 50 cities reported (Bureau of Transportation Statistics 1994). Solutions that add more highway capacity can be expected to provide only temporary relief. Few planners or engineers believe congestion can be reduced or even maintained at current levels. As the cost of highway expansions is rising, taxpayers' willingness to pay those costs is decreasing. Add to that the high cost of maintaining existing highways, and governments are hard pressed to finance new projects. The American Public Works Association (1996) reports that it would cost approximately $290 billion to eliminate existing highway and bridge deficiencies in the United States.

In most metropolitan areas, the suburbs have absorbed the lion's share of growth. In 1950, nearly 70 percent of the population in metropolitan areas lived in central cities. By 1990, that situation had reversed, with more than 60 percent living in suburbs (Rusk 1993). Beyond the urban core, land has been less expensive, and new highway capacity to serve it has been relatively easy to add. As a result, developed land area and vehicle use has increased much faster than population growth (Federal Highway Administration 1993). This suburban growth pattern has kept single-family housing prices within the range of many households, but often at the price of longer commutes. Moreover, some evidence sug-

Percent Change in Population and Daily Vehicle Miles Traveled (VMT) for Selected Urbanized Areas, 1989-1994

Urbanized Areas	Population	Daily VMT
New York	2.3%	4.6%
Los Angeles	7.0%	5.2%
Chicago	5.5%	22.2%
San Francisco	7.1%	3.9%
Dallas-Ft. Worth	6.4%	25.2%
Houston	4.8%	4.2%
Phoenix	14.1%	32.1%
Seattle	13.8%	11.4%
Denver	3.4%	30.3%
Portland-Vancouver	11.6%	19.2%
Sacramento	15.8%	11.6%
Las Vegas	148.3%	59.3%
Spokane	7.6%	29.0%

Note: Urbanized areas comprise one or more central places and the adjacent urban fringe having a density of at least 1,000 persons per square mile. Areas defined as "urbanized" grow as surrounding land develops to this minimum density.

Source: Federal Highway Administration (1990, 1995)

National Journey to Work Comparisons, 1980 & 1990

Percent of All Workers	1980	1990	Change
Driving Alone	64.4%	73.2%	13.7%
Carpooling	19.7%	13.4%	-32.0%
Public Transit	6.4%	5.3%	-17.2%
Other Modes	1.6%	1.3%	-18.8%
Walking or Working at Home	9.5%	6.9%	-27.4%

Source: Volpe National Transportation Systems Center, as reported by Pisarski (1990)

Percentage Growth in Population and Population Density for Selected Metropolitan Areas, 1950-1990

Urbanized Area	Growth in Population	Change in Density
New York	30%	-45%
Los Angeles	185%	26%
Chicago	38%	-38%
San Francisco	80%	-41%

Note: Density is in terms of persons per square mile. Urbanized areas comprise one or more central places and the adjacent urban fringe having a density of at least 1,000 persons per square mile. Areas defined as "urbanized" grow as surrounding land develops to this minimum density.

Source: U.S. Census Bureau, as reported in Cox (1996)

The costs of sprawl

Numerous studies have addressed the costs of sprawling versus compact development. While results are varied, many conclude that infrastructure costs are lower in high-density communities.

- A 1995 review of three major studies summarized the relative infrastructure costs of compact versus standard development patterns.

Relative Infrastructure Costs of Compact Development Relative to Standard Development Patterns

Findings From Three Major Studies				
Type of Facility	Duncan 1989	Frank 1989	Burchell 1992	Synthesis*
Roads	40%	73%	76%	75%
Schools	93%	99%	97%	95%
Water & Sewer	60%	66%	95%	95%
Other	102%	na	na	100%

*Represents a synthesis or consensus from the three studies, as reported by Burchell and Listokin.

Source: Burchell and Listokin (1995).

- The American Farmland Trust (1995) found that distributing the same amount of population growth between 1995 and 2040 over slightly less than one-half million acres, instead of slightly more than one million acres, would create cumulative savings for taxpayers of $29 billion. The low-density growth pattern would produce a cumulative local government deficit of over $1 billion.
- Another recent report (Bank of America et. al. 1995) found that the social, environmental, and economic costs of sprawl threaten to inhibit economic growth and degrade quality of life in California.

gests that the full costs of development in the suburbs are not paid by the people who choose to live and work there.

Citizens surveyed about growth consistently cite concern over congestion, air quality, sprawl (including loss of farmland, open space, and community), and change. They also report that they don't want growth to strip them of a sense of neighborhood and community, qualities they value. While citizens perceive the problems of metropolitan growth, they are skeptical that current policies and institutions can solve them (Deakin 1989, ECONorthwest 1994, Myers 1987). In short, many people believe that land development and traffic growth threaten their quality of life, and they question the ways in which that growth has been accommodated.

Seeking Solutions

Planning for livable communities

Planners and policymakers have long known that land development, transportation investment, and air quality are related, but for both technical and political reasons, simultaneously planning for all of them has rarely occurred. In the last five years, planners in metropolitan areas have increased their efforts to bring together different agencies, with different responsibilities, to develop integrated regional plans. The LUTRAQ project explored ways to achieve such integration.

The LUTRAQ project began with the assumption that good planning for metropolitan areas must integrate three key elements: land-use policy, transportation investments, and supportive market strategies.

- **Land-use policy**. Land-use planning is logically, and traditionally, at the core of a metropolitan area's efforts to create its future. While most traditional land-use plans set standards for new development, many of these standards actually work to facilitate, or even promote, sprawl. To avoid a sprawled future, land-use plans need to promote more compact development, reduce reliance on the automobile, and protect open spaces.
- **Transportation investments**. While many resources are currently allocated for highways, integrated planning must explore the benefits of investing in alternative modes of transportation (transit, bicycle, and pedestrian). Metropolitan areas are now encouraged to do this by the planning requirements and flexible funding of the Intermodal Surface Transportation Efficiency Act.

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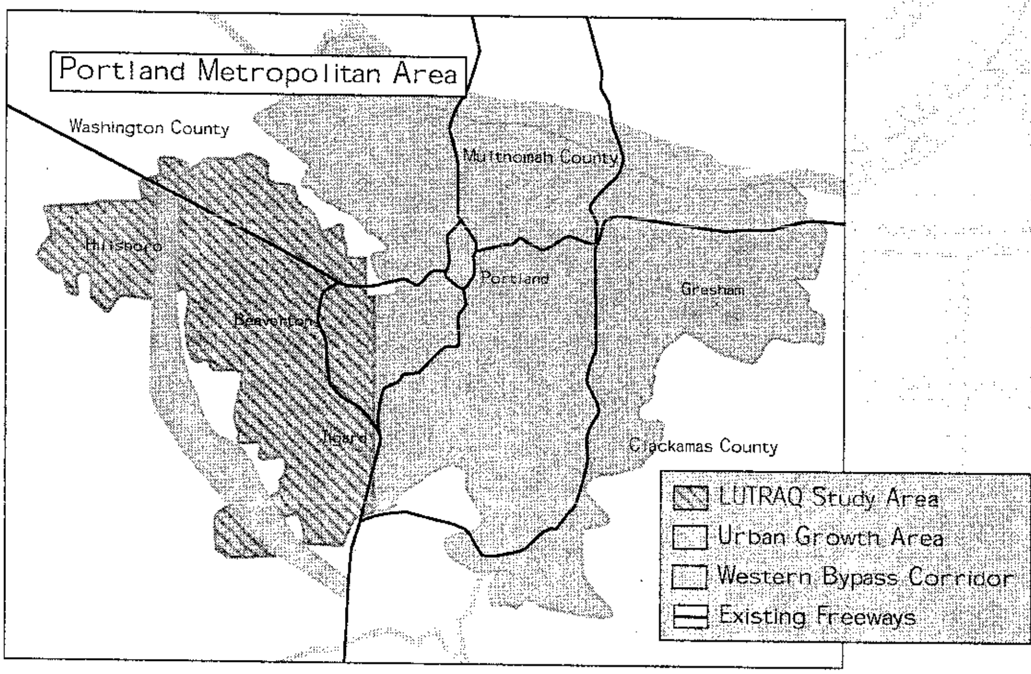
- **Market strategies**. Many public policies affect the market climate in which growth and transportation choices occur, thereby influencing the type and location of land development and the mode and destination of trips. In integrated planning, market strategies need to be employed to support the land-use and transportation objectives noted above. These strategies could include one or more of the following: parking pricing, congestion pricing, carpooling and transit incentives, economic development incentives for targeted locations, infrastructure fees, and tax policies.

Metropolitan areas face complex land-use, transportation, and environmental-quality problems that cannot be solved with simple measures. Change can occur, however, by addressing the issues from new perspectives and by weaving together a number of mutually supportive strategies.

Portland At The Crossroads

Trouble in paradise

Expanses of forest and fertile farmland, rushing rivers, and striking mountains surround the Portland metropolitan area. Nestled in the northwestern corner of Oregon, the region encompasses portions of three Oregon counties with a combined population of 1.2 million people. By the year 2040, the population is expected to increase by 760,000.



Land use and population growth

- Chicago metro area population grew by 4 percent between 1970 and 1990, but the region's land area grew by 35 percent (Northeastern Illinois Planning Commission 1995).
- Seattle metro area population grew by 38 percent between 1970 and 1990. During the same period, the region's land area increased by 87 percent and vehicle miles traveled ballooned by 136 percent (Arrington 1996).
- Kansas City's urban and suburban population expanded by 29 percent from 1960 to 1990, while total land area grew 110 percent (Kansas City Star 1995).

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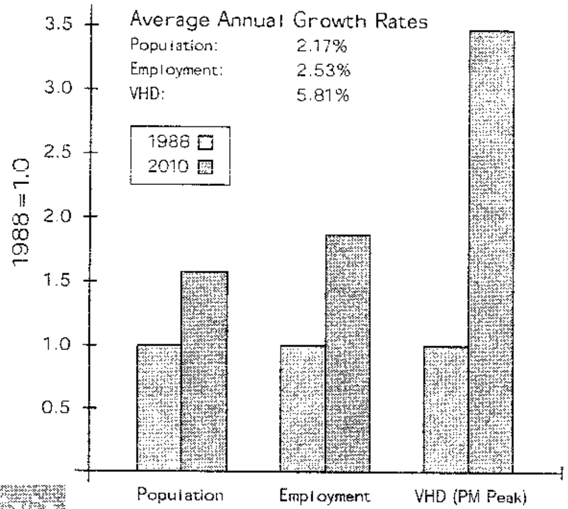
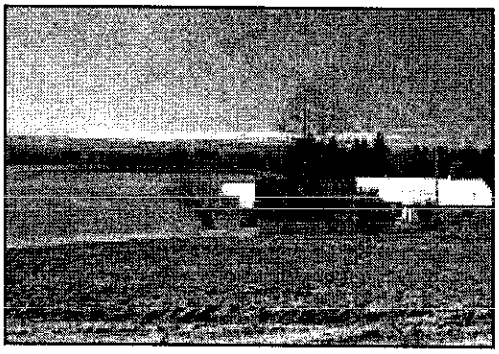
Population, Employment & Vehicle Hours of Delay - LUTRAQ Study Area (1988 & 2010)



Source: Oregon Department Of Transportation (1995)



This farmland, which lies in the path of the proposed Western Bypass, is as productive as it is beautiful; in 1995 Washington County farms produced more than $183 million in sales, putting the county fifth among Oregon's 36 counties.

Leading the region in growth is Washington County with an urban area of approximately 100 square miles in the western part of the metropolitan area. By 2010, the county will be home to 150,000 new residents and 100,000 new jobs.

Washington County has developed according to a typical auto-oriented, low-density, single-use development pattern. Only 3 percent of work trips are by transit, compared with 7 percent for the region as a whole. The county's segregated land-use patterns separate people's homes from the places they need to go; most people must use their cars to get to every destination.

Rapid growth, dispersed development patterns, and almost exclusive reliance on the automobile have combined to create heavy traffic and congestion. According to forecasts, traffic on main highways is expected to grow at twice the rate of population over the next 20 years. With traffic worsening, the initial political response was "build a new freeway."

Challenging assumptions

In 1988, the Oregon Department of Transportation (ODOT) and the political leadership of Washington County were close to agreement on building a new freeway, the Western Bypass. In response, 1000 Friends of Oregon initiated the LUTRAQ project.

By challenging conventional assumptions, the LUTRAQ project charted new territory in land-use and transportation planning. LUTRAQ did not accept the assumptions that providing mobility to a growing population required highways on an ever larger scale, that alternative modes would never provide significant relief from the need for auto trips, or that the number and length of trips could not be reduced by changes in land-use and other policies. Instead, LUTRAQ presented new assumptions that were tested by careful analysis of market and demographic trends. The result was the LUTRAQ alternative, a different plan for land use and transportation that was added to ODOT's environmental impact statement process for the Western Bypass and, ultimately, adopted as part of the region's vision for the future.

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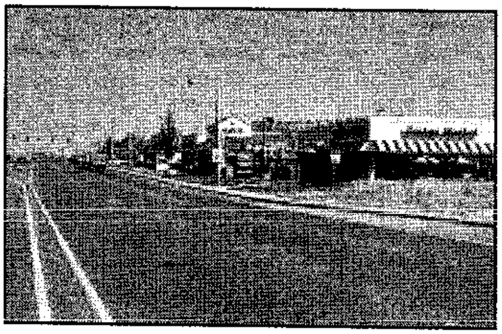
A vision of choice

The LUTRAQ alternative envisions suburban neighborhoods where adults and children can choose how they travel to and from life's destinations. It suggests new residential and commercial patterns that emphasize connected streets, sidewalks, convenient and comfortable access to transit, mixed uses, human-scale design, and open space.

To transform that vision into a reality, LUTRAQ proposed three principles for public action:

- Land-use plans should direct higher intensity development to locations well-served by transit and should ensure that development is designed for pedestrians, bicyclists, and transit riders, as well as auto drivers.
- The transportation system should serve and reinforce the nature of that development.
- Market strategies should further support that development by correcting some of the current distortions in the pricing of the transportation system and other public facilities.



Retail commercial development can be designed in a number of ways. Options include auto-dependent designs that lack human scale and connections to homes, schools, and other key destinations and pedestrian-friendly designs that invite walking and bicycle travel.

CQ535

Summary

This volume summarizes the work undertaken by the LUTRAQ project team and Metro (the Portland regional government) to enhance the Portland area land use and transportation forecasting and analysis procedures. Efforts included enhancement of the transportation models, and integration of the transportation models with land use models.

n Travel Model Enhancements

In Volume 1 of the LUTRAQ project reports, the project team determined that the Portland travel forecasting system, while one of the most advance in use in the U.S., had deficiencies that limited its usefulness in evaluating the effects of land use/transportation strategies.[1] To alleviate these problems, the project team, in cooperation with Metro, developed several model enhancements.

Four models—auto ownership, destination choice, pre-mode choice, and mode choice—were revised. The auto ownership model predicts levels of car ownership (0, 1, 2, 3+) at the household level. Its outputs are important inputs into the trip generation, pre-mode choice and mode choice models for home-based trip purposes. Destination choice, or trip distribution, determines the attraction ends of the trip productions estimated in the trip generation model. Destination choice therefore implies a trip length distribution as it estimates the number of trips from each origin zone to the other zones in the metropolitan area. The pre-mode choice model estimates the percentage of trips using the walk or bicycle modes for each origin-destination zone pair. The mode choice model determines how many vehicular trips use the auto mode and how many use transit. For home-based work trips, the split between single occupant auto and carpool, and between auto and walk access to transit is also estimated.

The primary revisions to the auto ownership, pre-mode choice, and mode choice models were the additions of variables to make the models more sensitive to variations in the heterogeneity of development (the degree to which land uses are mixed), and the quality of the pedestrian environment. Regarding land use density and heterogeneity, the project team tested several forms of variables in the model structure. The most useful, and statistically reliable, was a measure of retail density. Specifically, the number of retail jobs within one mile of the center point (centroid) of a traffic analysis zone proved to be statistically significant in explaining auto ownership and pre-mode choice.

To address the quality of the pedestrian environment, a new variable, called the "pedestrian environment factor" (PEF), was created. The measure represents a composite measure of the "pedestrian friendliness" of each of the analysis zones in the model system. It was developed in acknowledgment of the fact that a number of factors at the neighborhood and street level affect an individual's willingness and ability to choose the walk mode for various trip purposes. As devel-

1. 1000 Friends of Oregon, *Making the Land Use, Transportation, Air Quality Connection,* Vol. 1, *Modeling Practices* (Portland, Oregon, 1991).

oped by the Metro staff in consultation with the project team, the PEF consists of an assessment of each zone on four different parameters:

- Ease of street crossing
- Sidewalk continuity
- Street connectivity (grid versus cul-de-sac)
- Topography[2]

In addition to the above model improvements, the destination choice model was improved by changing the computation of intrazonal travel time, thereby enhancing the model's ability to calculate intrazonal trips.

Overall, the model enhancements were successful in improving the ability of the forecasting system to estimate demand over wide ranges of development densities and pedestrian environments. The model improvements were particularly effective in improving the ability to estimate the effect of development density and pedestrian environment on the pre-mode choice (walk/bike vs. vehicle) for home-based trips.

n Land Use Model

A significant part of the LUTRAQ project has been the integration of location and land use forecasting procedures with the transportation modeling procedures currently in use for the region. To accomplish this the project team recommended making use of the Employment Allocation Model (EMPAL®)[3] and the Disaggregated Residential Allocation Model (DRAM®)[3], developed by S.H.Putman Associates. These models were integrated into the Metro transportation modeling process, and a series of analyses were completed in 1992. Though successful, the results revealed the need for further analyses. This revised version of *Volume 4: Model Modifications* describes the results of complete new analyses, including tests of revised and extended versions of the models.

As part of this effort, the Portland data were completely re-examined and, in some instances, revised. Tests were then performed on different versions of the Portland data, as well as on data for two other regions: Detroit and Kansas City. The "three region tests," begun with the work on DRAM, involved examination of new extended forms of the DRAM model, and in the EMPAL work, the addition of new variables. A series of "geographic detail" tests were also done for Portland.

The "three region tests" for EMPAL examined the addition of prior time period employment loca-

2. For more information on the PEF, *see* 1000 Friends of Oregon, *Making the Land Use, Transportation, Air Quality Connection*, Vol. 4A, *The Pedestrian Environment* (Portland, Oregon, 1993), *and* ibid. Vol. 6, *Implementation* (1995), App. B.
3. EMPAL and DRAM are registered trademarks of S.H.Putman Associates, Inc.

tion data to the model structure. This data was not available for previous work with the model. With the adoption of GIS analysis techniques, it became possible to economically prepare intercensal estimates of employment and household location, even though at present, there are still serious questions about the reliability of some of the Portland employment data. The results of our analyses showed that *the addition of prior time period employment data to the EMPAL model structure does* ***not*** *yield a significant improvement to the model's predictive ability.* These improvements might have been forthcoming but for the difficulties discovered with the data.

Given the presence of systematic problems in the Portland data, an alternate approach to improving the model's predictive ability involved aggregating the geographic zone structure in an attempt to cancel out some of the data errors. *After aggregation of the zones from the 328 census tracts to 100 analysis zones there were improvements in the Portland calibration results.* At the census tract level of detail the extended model accounts for 72% to 82% of the spatial variation in employment location. At the 100 zone level of detail the extended model accounts for 85%to 94% of the spatial variation. Even so, there are still some questionable parameter values. Tests of inclusion of a variable to account for the zones being inside or outside of the region's Urban Growth Boundary yielded no improvement in model performance.

As with EMPAL, the "three region tests" for DRAM examined the addition of prior time period household location data to the model structure. In contrast to the EMPAL analysis, the results here showed that *the addition of prior time period household data to the model structure yields substantial improvements in the model's predictive ability.* These improvements ranged up to 50% for some household types in some regions. The results were consistent across all three of the regions. Two different ways of including these variables were examined, the determination of which was most appropriate being dependent upon the quality of the data available.

Again, the results for Portland indicated the presence of systematic problems in the data. Following the approach used with EMPAL to correct similar problems, aggregation of the geographic zone structure was tested in an attempt to cancel out some of the data errors. Results showed that *aggregation of the 328 census tracts into 100 analysis zones significantly improved Portland's calibration results.* At the census tract level, the extended model accounts for only 79% to 87% of the spatial variation in household location. At the 100 zone level, however, the extended model accounts for 92% to 98% of the spatial variation. Tests of the inclusion of a residential land value variable yielded no improvement in model performance.

Having completed the examination of data resources and the subsequent recalibrations of EMPAL and DRAM, the team turned its attention to preliminary tests of the linked model system. Numerous computer runs were done to test different procedures for forecasting the evolution of employment and household location patterns in the metropolitan Portland/Vancouver region.

The first step was to develop a *baseline* run, a forecast which takes the assumption that no new policies will be implemented, but that the economic and demographic development of the Portland region, as defined by Metro in its regional forecasts, will continue as in the past, and the resulting spatial patterns will be reflective of prior location, transportation, and land use practices. All the test runs were made for a single 5-year forecast period (i.e., from 1990 to 1995). This was done to keep our principal focus on the ways in which models were linked, and what the consequences of alternate configurations of linkages might be. The baseline was done using the traditional procedure of starting with a fixed set of zone-to-zone travel times and then simply making a run of EMPAL and DRAM to get the forecast.

The linked transportation and land use model runs were made by starting with a fixed set of zone-to-zone travel times, running EMPAL and DRAM, then taking the employment and household forecasts and using them as input to the Metro travel demand models. The forecasts of trips were then assigned to the Metro transportation networks using the EMME/2 package. The resulting congested travel times were used to re-run EMPAL and DRAM. The process was iterated until equilibrium was achieved. Using the proper procedure to perform the linkage *the linked transportation-land use model system readily converges to a unique equilibrium solution.* The equilibrium solution has the property that *a measure of location surplus for households is maximized, and the user-equilibrium criterion for optimal assignment of trips to the network is minimized.*

These methodological results were obtained for two very different levels of geographic detail. The numerical results were, however, different. At higher levels of geographic aggregation significant portions of the region's trips were missed, i.e., they are not seen on the network, and thus the network congestion is underestimated and the model system outputs are different from those done at a finer level of geographic detail. The degree to which linked model run results, after a singe 5-year forecast period, differ from traditional results, depends upon the level of congestion on the transportation network. This can, in turn, depend upon the geography being used in the analyses. Maps depicting the results of these model runs are presented in the Appendix of this volume at pages 86-99. Full details will be available in the final report of a separate study being conducted by S.H.Putman Associates for the Federal Highway Administration to thoroughly examine the behavior of alternative configurations of linked transportation and land use model systems.

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1.0 Introduction

Across the United States, local, state, and federal agencies have been working in recent years to make the "land use, transportation, air quality connection." Motivation for these efforts has come from a number of sources, including state and federal legislation, international agreements, and local initiatives.

At the national level, the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) has been a prime motivator. Among other provisions, ISTEA requires states and metropolitan planning organizations (MPOs) to consider

> "[t]he likely effect of transportation policy decisions on land use and development and the consistency of transportation plans and programs with the provision of all applicable short- and long-term land use and development plans."[1]

It also requires consideration of methods to expand and enhance transit services, and ways to increase the use of such services. Similarly, the 1990 Clear Air Act Amendments require states to consider the use of demand-management strategies to reduce vehicle use and improve air quality, including strategies that would alter land-use and development patterns.

Internationally, the United States is a signatory to the U.N. Framework Convention on Climate Change developed at the 1992 Global Summit in Rio de Janeiro. The Convention commits signatory countries to decrease greenhouse gas emissions. Though the amount of reduction was not agreed upon, the U.S. has indicated its support for stabilizing CO_2 emissions at 1990 levels (Clinton, 1993). Transportation contributes slightly more than thirty percent of the nation's total CO_2 emissions; two-thirds of those emissions are produced by automobiles (EPA, 1995a). This has led some governmental agencies to focus on ways to cut transportation demand. In some cases, this has included land-use strategies (Portland, 1993).

Locally, some efforts at land-use/transportation integration have been inspired by the national and international provisions mentioned above. Many more, however, have occurred through simple desires to improve quality of life at regional and neighborhood levels, to reduce the need for roadway expenditures, or to increase transit ridership.

Thus, whether the impetus is an international treaty or a neighborhood issue, jurisdictions have increasingly acknowledged the importance of land use in assessing transportation and air-quality policy options. During the past six years, 1000 Friends of Oregon has published a series of technical reports relating to these issues as part of *Making the Land Use, Transportation, Air Quality Connection*, better known as the LUTRAQ project:

> Volume 1: *Modeling Practices* (1991). The *Modeling Practices* report reviews the state-of-the-practice in integrated land-use modeling in the United States and aboard.

1. 23 U.S.C. § 134(f)(4); *see also* 23 U.S.C. § 135(c)(14).

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It also summarizes the characteristics and structure of the travel-demand forecasting system used in the Portland, Oregon metropolitan area, which includes the LUTRAQ project study area.

Volume 2: *Existing Conditions* (1991). Volume 2 is a base-line study, containing an analysis of existing land-use and socioeconomic conditions in the LUTRAQ study area.

Volume 3: *The LUTRAQ Alternative* (1992). Volume 3 provides a detailed description of the pedestrian- and transit-oriented land-use/transportation/demand-management elements of the LUTRAQ alternative.

Volume 3A: *Market Research* (1992). In Volume 3A, the authors assess the demands for residential and non-residential real estate in the study area. This independent assessment of market trends became the basis for developing the transit-oriented neighborhoods contained in the LUTRAQ alternative.

Volume 4: *Model Modifications* (1992). The *Model Modifications* report describes enhancements made to the Portland region's travel-demand forecasting model to make it more responsive to land use. It also reports on the calibration process of land-use models developed by S.H.Putman Associates for use in the Portland metropolitan area.

Volume 4A: *The Pedestrian Environment* (1993). *The Pedestrian Environment* focuses on the ways in which the characteristics of the built environment affect automobile dependence. It quantifies the contributions made by such factors as street and sidewalk connectivity on the use of automobiles and alternative modes in the Portland metropolitan area.

Volume 4B: *Building Orientation* (1994). *Building Orientation,* a supplement to *The Pedestrian Environment,* focuses on the role played by proximity of commercial buildings to the street in influencing automobile and transit use.

Volume 5: *Analysis of Alternatives* (1996). Volume 5 contains the results of the simulations conducted for the LUTRAQ project. It presents findings of the transportation impacts of the LUTRAQ alternative, and includes estimates of the alternative's air-quality, energy-consumption, and greenhouse gas benefits. These data are compared to similar measures made of other scenarios, including those that focus on highway development.

Volume 6: *Implementation* (1995). The *Implementation* report contains a sample set of design guidelines which communities can use to implement neo-traditional design principles, a model zoning ordinance, and a discussion of ways to use transportation impact fees to encourage the construction of neo-traditional development patterns.

In addition to these reports, there is a summary report—*Making the Connections: A summary of the LUTRAQ project*—that, combined with this technical report, compiles key conclusions from the project, and is designed for use by a wide audience of citizens and elected officials.

This technical report does more, however, than summarize previous LUTRAQ findings and conclusions. Chapter 2 attempts to summarize what is known about the relationships between transportation and urban form, drawing not only from our work on the LUTRAQ project, but also from a wide variety of research around the United States and the world. It discusses the ways in which urban form influences travel patterns, and, conversely, the ways in which transportation investments influence land use and urban form. The chapter summarizes the connection between these relationships and the air-quality problems faced by many metropolitan areas.

Chapter 3 presents a step-by-step approach to developing an integrated transportation and land-use plan. For each step in the process, the chapter identifies the basic questions which need to be answered. It summarizes the ways in which the LUTRAQ project has shed light on these questions, and identifies lessons which have been learned from other, similar projects across the United States.

The intent of this volume is to furnish a working plan for communities, agencies, and organizations seeking to re-think their planning processes. The report emphasizes the importance of creating alternative visions for metropolitan growth and development, developing sound alternatives, evaluating them carefully, and implementing a recommended plan.

During the last six years, work on the LUTRAQ project and on similar projects across the United States has generated a wealth of experience from which many valuable lessons can be drawn. We hope that this body of experience is well summarized in the pages that follow, and that this combination of knowledge and advice will support and inspire citizens, policy leaders, and technical staff interested in transportation and land-use relationships in metropolitan areas.

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Transit-oriented development objectives

- Increase use of existing urbanized areas accessible to transit through:
  Infill – putting new development on passed-over vacant parcels in existing developed areas;
  Redevelopment – replacing older structures with new ones of different and denser uses in existing developed areas.
- Reduce the number of auto trips by creating opportunities to walk, bike, and use transit.
- Create a local street network that allows direct connections to local destinations without diverting extra traffic onto the arterial and highway system.
- Protect the natural environment and community character by reducing the need for roadway expansions.
- Reduce air pollution and conserve energy.
- Provide a range of housing types to serve diverse households.
- Foster a vital, connected, and secure community.

Transit-oriented development characteristics

The right location. Proximity to transit is a key factor in TOD site selection.

Connected streets. TODs provide an internal, interconnected system of tree-lined, reduced-speed streets that link local destinations, thereby reducing congestion on nearby arterials.

A walkable environment. TODs bring many destinations in close proximity, reinforcing the opportunity to run errands in a short period, without a car.

A mixture of uses. TODs incorporate residential and commercial uses, parks, and public facilities that can be reached without driving.

THE PROCESS OF CHANGE

Land Use That Supports Multi-Modal Transportation

Transit-oriented development

The characteristics of transit-oriented development (TOD) aren't new. They are, in fact, similar to those of American urban neighborhoods developed in the first half of this century. Families can walk a few blocks to buy groceries, mail a package, or share a meal. Houses are closer together, with front porches that create opportunities for connections with neighbors. Cars are parked behind houses in garages located off alleyways. Traditional street grids, rather than cul-de-sacs, provide direct connections to local destinations.

Denser, mixed-use developments also make it more likely that people will use transit for trips that are too far for walking. With more people living close to light-rail or bus transit centers, transit providers can offer a convenient alternative to automobiles by providing more frequent service. LUTRAQ's analysis illustrated that linking a series of these developments to a reliable transit network can significantly reduce the number of car trips by providing a convenient, reliable alternative to driving.[1]

The LUTRAQ alternative focuses on three general varieties of transit-oriented developments, each with its own purpose and qualities: Mixed-Use Centers, Urban TODs, and Neighborhood TODs.

Mixed-Use Centers

Mixed-Use Centers incorporate new commercial, office, and residential uses into existing "city centers" and emerging employment and retail centers. These areas are planned to contain the highest commercial intensities and residential densities, as well as the greatest mix of shopping, jobs, and housing within walking distance of transit. All are served by existing or planned light-rail transit.

The LUTRAQ analysis aimed to allocate about 40 percent of the land in Mixed-Use Centers for residential development

[1] See LUTRAQ Vol. 8: *Making the Connections: Technical Report* for details of the modeling and assumptions that led to this conclusion.

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(ranging from 12 to 50 units per net acre), 15 percent for retail commercial (primarily in ground-floor locations), 30 percent for high-intensity employment such as offices, and 15 percent for low-intensity employment such as light industrial.

Urban Transit-Oriented Developments

Urban TODs are planned for lands located outside Mixed-Use Centers in areas that are more appropriate for residential uses than office and employment centers. They are situated around light-rail stations and express-bus stops. The LUTRAQ analysis aimed for residential densities in Urban TODs ranging from three-story apartment buildings (30 units per net acre) to small-lot single-family houses (seven units per net acre), with an average of 15 units per net acre.

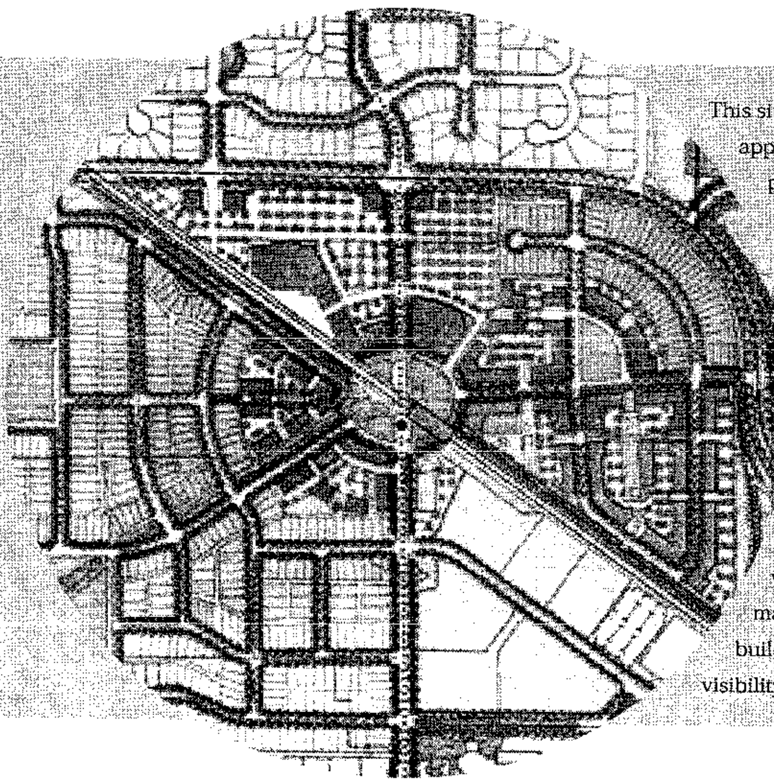
Neighborhood Transit-Oriented Developments

Neighborhood TODs are planned for lands located on feeder bus lines within 10 minutes of light-rail or express-bus stops. These areas place a greater emphasis on residential uses and locally oriented shopping than the other development

Transportation Impacts Of Transit-Oriented Development

	Standard Suburban Development	Transit-Oriented Development
Auto Ownership		
Percentage of Homes Owning 0-1 Autos	29.4%	44.1%
Average No. of Autos/Household	1.91	1.63
Work Trip Mode Choice:		
Walk/Bike	2.8%	5.0%
Transit	7.5%	28.2%
Carpool	14.0%	17.2%
Drive Alone	75.8%	49.6%
Vehicle Trips/Household	7.53	5.79

Source: LUTRAQ Vol. 5: Analysis of Alternatives



This site plan demonstrates how TOD principles might be applied to a Washington County site that surrounds a planned light-rail stop. The area currently has large tracts of vacant and underutilized land in close proximity to the light-rail station at 170th Avenue. Most existing housing is single family, with some pockets of multi-family housing and industrial and institutional uses. The site plan establishes a new neighborhood center with retail and civic uses adjacent to the planned light-rail station. This center is surrounded with moderate and high-density residences and various forms of small-lot single-family housing. The retail center would contain a major grocery store, a six-plex cinema, ancillary shops, and a small professional office building, arranged to provide convenient access and visibility along the arterial.

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types. As with all TODs, the interconnected street system focuses trips to the core commercial area, rather than exclusively to the arterial street system.

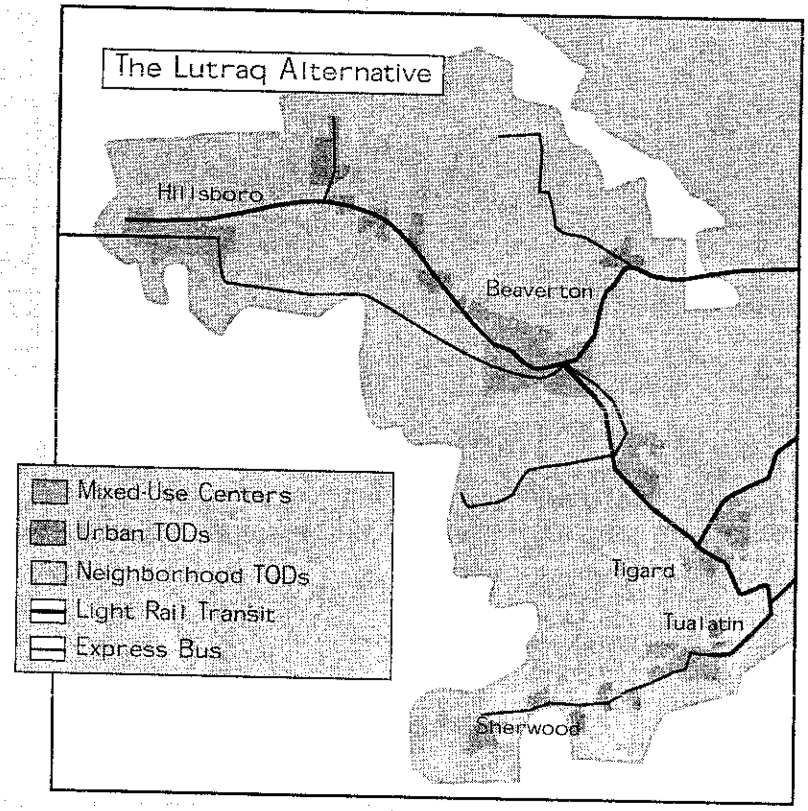
For residential uses in Neighborhood TODs, the LUTRAQ analysis assumed densities ranging from town houses (20 units per net acre) to standard single-family houses (five units per net acre), with an average of eight units per net acre.

The LUTRAQ land-use plan incorporates the three types of transit-oriented developments. Mixed-Use Centers include the most intensive configuration of jobs, retail, and housing. Urban TODs include moderate to high residential densities and a core area of commercial retail and services. Neighborhood TODs include moderate-density residential and local-serving retail.

From principle to practice

Incorporating transit-oriented development into an alternative for an environmental impact statement process required thorough analysis of demographic projections, vacant and underutilized lands, and market trends. The analysis revealed several factors favoring development of TODs:

- Increasing demand for multi-family housing
- Rapid growth in retail employment
- A good supply of land in proximity to existing or planned transit routes



More than 22,000 acres, approximately one-third of the land inside the urban growth boundary in Washington County, were identified as vacant or underutilized. From this supply, unbuildable lands (wetlands, steep slopes, and protected areas) were removed. Of the remainder, lands within one-half mile of the light-rail and express-bus system were considered eligible for Mixed-Use Centers and Urban TODs, lands within two miles of that system were deemed eligible for Neighborhood TODs, and the balance was slated for low-density residential use.

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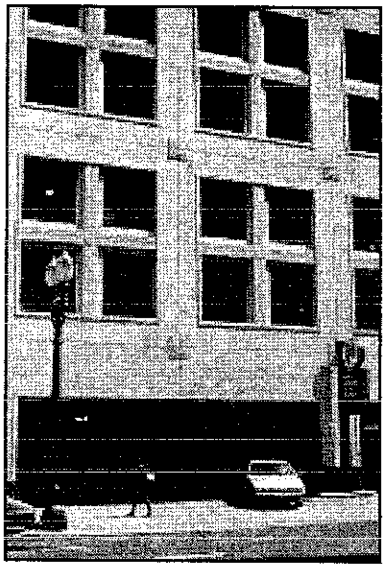
The Transportation Link

The transportation element of the LUTRAQ alternative relies upon existing transit plans for the Portland metropolitan area. The facilities contained in those plans, some of which are already under construction, are designed to serve areas targeted for population and employment growth. Building on these plans, the LUTRAQ alternative includes the following features:

- **Light rail.** New residential and commercial development is oriented along two new light-rail corridors that radiate west from the region's urban center, plus a circumferential light-rail line along the existing suburban beltway.
- **Express bus.** Outlying areas are served by express buses to major activity centers.
- **Local feeder buses.** Feeder buses serve residential areas not directly served by light rail or express buses, providing convenient connections to a trunk line service.
- **Demand-responsive transit.** This program includes dial-a-ride, shared ride, and shuttle services to destinations within a specific subarea at fares equal to regular transit fares.
- **Bicycle and pedestrian improvements.** These facilities include sidewalk networks, safe and convenient street crossings, and bicycle and pedestrian pathways.
- **Roadway improvements.** Modest improvements to the roadway network allow existing roads to be used more efficiently.



Market Strategies

The land-use and transportation elements of the LUTRAQ alternative can be fully successful only if they are supported by other public policies, particularly those that affect market conditions for land development and transportation. Many analysts argue that automobile drivers do not pay the full costs they impose on society. Raising the costs of auto travel, coupled with making alternatives more attractive, creates incentives to reduce auto use. Indirectly, these changes also encourage development in transit-oriented areas.

Transportation costs can be adjusted by increasing the price or reducing the supply of parking, supporting employer programs to encourage carpooling and transit use, and charging for highway use by location and time of day (congestion pricing). The following policies were included in the LUTRAQ alternative:

- **A daily parking charge**. This charge applies to all commuters who drive alone to work sites in the study area. The parking charge is $3 per day, approximately one-third the cost of parking in downtown Portland. Carpooling commuters and drivers with non-work destinations are not subject to the charge.
- **A free monthly transit pass**. Everyone working within the study area could ride transit for free. The alternative proposes that this program is at least partially funded by revenue from parking charges.

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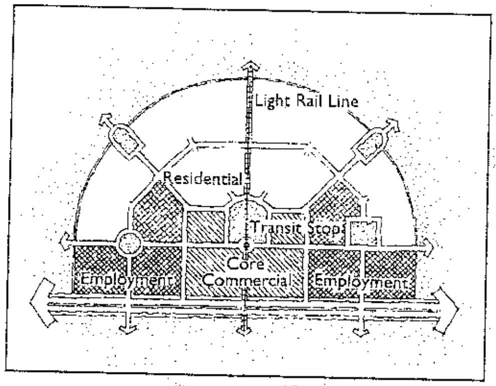
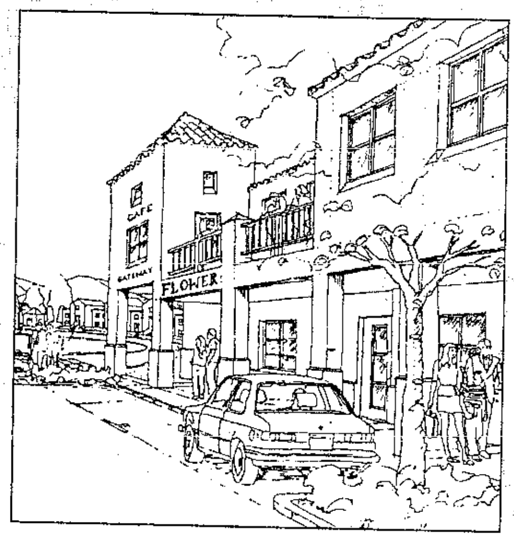
From Vision To Action

Obviously, planning for transit-oriented developments must occur before they can be built. To build them, local governments must first adopt design guidelines or zoning regulations that encourage, or at least make possible, transit-oriented development. Ideally, new standards should accomplish the following:



- **Transit stops.** Stops should be located adjacent to core commercial areas. Whenever possible, transit stops should be adjacent to commercial buildings, rather than surrounded by large parking lots.
- **Street configuration.** All streets should provide direct auto, bicycle, and pedestrian connections to transit, core commercial areas, schools, and parks. They should be designed and landscaped to make them attractive for users of all transportation modes. The street system should provide multiple routes between core commercial areas and surrounding neighborhoods without requiring use of major arterials.
- **Pedestrian connections.** Pedestrian routes should be adjacent to, or visible from, streets and be linked to local destinations and building entrances. Where street connections are not feasible, short pedestrian paths should be provided.
- **Commercial configuration.** Retail and commercial space should be clustered close to transit stations or stops.
- **Building entries.** Commercial building entrances should be oriented to plazas, parks, or pedestrian-oriented streets, rather than interior blocks or parking lots.
- **Building setbacks.** Building setbacks should be reduced and standardized to provide closure for the street space and to establish a consistent building line.
- **Mixed housing.** Transit-oriented developments should encourage a mix of housing densities, ownership patterns, prices, and building types.
- **Minimum densities.** Minimum densities should be established for both commercial and residential development.
- **Parks and public uses.** Parks and plazas should be placed next to public streets, residential areas, and retail uses to create community focal points. They should not be formed from residual areas, used as buffers to surrounding developments, or used to separate buildings from streets.
- **On-street parking.** All streets except major arterials



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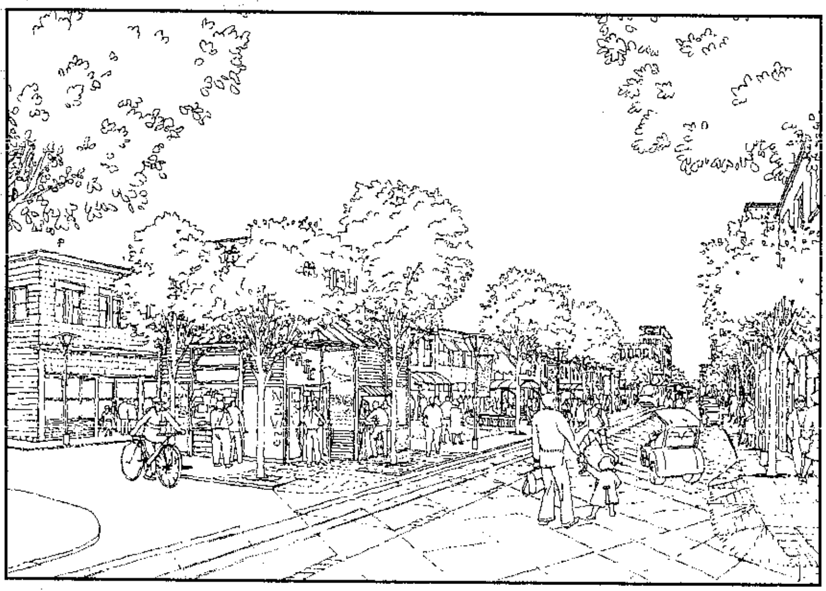
should provide on-street parking. Where feasible, landscaping and bikeways should be added to existing streets.

- **Off-street parking**. Off-street parking should be located in surface lots on the side or at the rear of buildings, underground, or in parking structures. It should not be located between a building and a pedestrian route, an adjacent transit street, or a light-rail transit station site.
- **Parking configuration**. Parking lots should not dominate pedestrian-oriented streets or interrupt pedestrian routes. Large surface parking lots should be divided into smaller lots that resemble city blocks.
- **Integrated uses**. Site plans should integrate existing uses by respecting ongoing operations, basic access requirements, and, if appropriate, existing building massing and architecture.
- **Auto-oriented uses**. Auto-oriented uses should be limited or prohibited.

Motivating developers to build transit-oriented developments requires more than supportive design guidelines and zoning ordinances. Economic incentives, which reduce the costs developers must bear, are also helpful. These can include fee reductions, decreased parking requirements, faster permit approvals, density bonuses, master planning and infrastructure development, and public investments in pedestrian facilities and parks.



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Comparing The Alternatives

LUTRAQ makes a difference

The LUTRAQ alternative was compared to several more traditional approaches to addressing transportation needs: a "No Build" option, in which population, employment, and travel grew but transportation capacity did not, and a "Highways Only" option, in which new highway capacity, including the Western Bypass, was added to accommodate growth.

The analysis showed that, at the end of 20 years, the LUTRAQ alternative had the potential to be superior to the "Highways Only" option on all key criteria used in the evaluation:

- 22.5 percent fewer work trips made in single-occupant vehicles
- 27 percent more trips made on transit and by walking and biking
- 18 percent less highway congestion with 10.7 percent fewer hours of vehicle travel during the afternoon rush hour
- 21 percent greater access to jobs in the region, as measured by the percentage of the study area within 30-minutes travel of 500,000 jobs
- Reduced emissions of air pollutants: hydrocarbons (-6 percent), nitrogen oxides (-8.7 percent), and carbon monoxide (-6 percent)
- 7.9 percent fewer emissions of greenhouse gases (methane, nitrous oxide, and carbon dioxide)
- 7.9 percent less energy consumed

The advantages of the LUTRAQ alternative over the highway alternative were even stronger for households and businesses located within transit-oriented developments.[2]

LUTRAQ vs. Alternatives

	No Build	Highways Only	LUTRAQ	LUTRAQ TOD Areas Only
Work Trip Mode Choice:				
Walk/Bike	2.8%	2.5%	3.5%	5%
Transit	7.5%	8.8%	18.2%	28.2%
Carpool	14%	13.6%	20.1%	17.2%
Drive Alone	75.8%	75.1%	58.2%	49.6%
Vehicle Trips/Household	7.53	7.5	7.17	5.79
Vehicle Hours of Delay (compared to No Build)	–	-43%	-53.2%	
Vehicle Miles Traveled (compared to No Build)	–	1.6%	-6.4%	

Source: LUTRAQ Vol. 5: Analysis of Alternatives

[2] For more information on the results of the LUTRAQ analysis, see LUTRAQ Vol. 5: *Analysis of Alternatives.*

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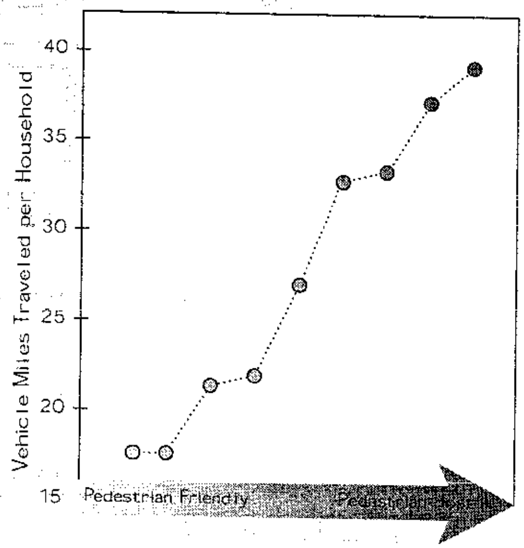
Pedestrian Environment Factor

The Pedestrian Environment Factor (PEF) was created as a new variable to enhance Portland-area travel forecasting. The PEF measure, developed by Metro staff with the LUTRAQ project team, is a composite of four attributes of a neighborhood's natural and built environment — ease of street crossings, sidewalk continuity, local street connections, and topography (slopes).

Though many other factors go into creating a pedestrian-oriented environment, these four attributes are significant in classifying a neighborhood's pedestrian friendliness. The LUTRAQ analysis revealed that households in neighborhoods with the highest PEF ranking traveled in vehicles less than half as many miles as households in the lowest PEF neighborhoods. When other variables such as household size and income were held constant, the quality of the pedestrian environment still showed a significant effect. The data suggested that transforming a pedestrian-hostile neighborhood into one that is pedestrian friendly could result in a 10 percent reduction in vehicle-miles traveled per household.

Pedestrian Environment/Miles Traveled



Source: LUTRAQ Vol. 4A: The Pedestrian Environment

New land-use and transportation models

The kinds of comparisons shown above were possible, in part, because of analytic procedures developed by the LUTRAQ project. For example, LUTRAQ improved the standard process of travel demand forecasting by quantifying a new concept—the Pedestrian Environment Factor (see sidebar). However, LUTRAQ was less successful in predicting accurately how highway and transit investments affect land-use patterns. New and better tools are still needed to measure the interaction between land use and transportation.

Changing Policy

The LUTRAQ success story

Without the LUTRAQ project, Washington County would likely be headed toward very different transportation solutions. In 1990, the Oregon Department of Transportation was considering only highway, arterial, and "no-build" alternatives for Washington County. In 1992, the LUTRAQ alternative was published, and, with the help of the citizens group Sensible Transportation Options for People (STOP), was included in ODOT's environmental impact statement process.

In May 1995, that process determined the potential impacts of five alternatives, ranging from LUTRAQ to the Western Bypass. The analysis showed that the LUTRAQ alternative was the only option, other than the "no-build" alternative, that would conform with the requirements of the federal Clean Air Act. It also showed that the Western Bypass was inconsistent with Oregon's growth containment policies. In the summer of 1996, ODOT recommended a preferred alternative that includes only limited road improvements and endorses the land-use concepts in the LUTRAQ alternative. The Western Bypass was officially out of the game.

Beyond the borders of Washington County, LUTRAQ has also influenced regional and state policies. In 1994, Metro, the regional planning agency for the Portland metropolitan area, adopted a 50-year land-use and transportation plan (see page 24). The Washington County portion of the plan is virtually identical to the LUTRAQ alternative.

At the state level, the LUTRAQ project affected the content of the Oregon Transportation Planning Rule, which requires that local and regional governments in the Portland area promote compact, pedestrian, and transit-friendly development, reduce per capita vehicle-miles traveled, and evaluate potential land-use plan changes as part of their transportation planning processes.

Grassroots action

In addition to its technical and policy achievements, LUTRAQ offers a number of valuable lessons about how a grassroots movement can influence regional planning.

- **Plug into the process.** Active involvement in the public process is essential in effecting change. Although working outside the public process can be effective in raising public awareness, it is usually only inside the process that positive alternatives can gain acceptance. In the case of the Western Bypass, 1000 Friends of Oregon and STOP began by filing lawsuits against the project. To be effective in promoting a positive alternative to the bypass, however, it was necessary for the two organizations to participate in the environmental impact statement process.
- **Don't reinvent the process.** LUTRAQ did not spend time creating a new process for developing alternatives. Rather, it followed a process that is typical of planning projects:
  1. Clarify the project scope
  2. Decide who will be involved
  3. Define a range of alternatives
  4. Determine performance measures for comparing alternatives
  5. Simulate alternatives and interpret results
  6. Implement the preferred alternative
- **Work outside the box.** Working beyond established limitations is as important as playing the game. While working within the environmental impact statement (EIS) process, LUTRAQ was able to expand the typical definition of a transportation alternative to include demand management and land-use changes. LUTRAQ also funded independent analysis of its alternative in a way that allowed the results to feed back into the process. Finally, LUTRAQ extended its reach by carrying the alternative beyond the EIS and into the regional planning process.
- **Approach agencies as allies.** Grassroots organizations and government agencies are not necessarily at odds in the planning debate. However, governments are often limited by procedural and political constraints that do not impede citizens groups. Local grassroots organizations like STOP and 1000 Friends of Oregon were able to propose a solution that moved the debate into new territory.

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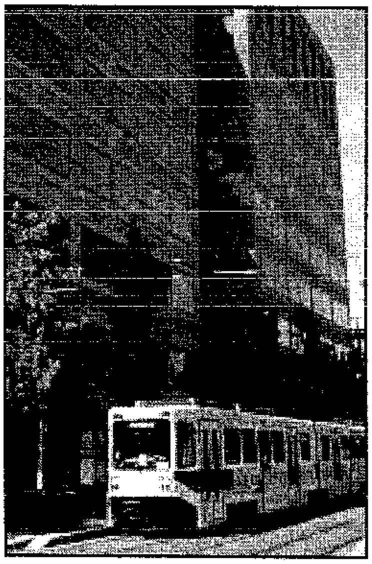
CASE STUDIES

LUTRAQ is only one of many projects that have contributed to progress in transportation and land-use planning in North America. A number of other examples follow.

Transportation Alternatives

The requirements of the federal Intermodal Surface Transportation Efficiency Act have prompted more metropolitan areas to incorporate non-automobile transportation alternatives into their transportation planning processes. Many regions now emphasize the relationships between these alternatives and land use in their transportation plans.



Rail

Regions considering rail systems today focus on light rail or commuter rail, which are more economical to develop than heavy rapid transit systems. In 1995, 17 U.S. cities had light-rail lines, and extensions were being planned or were under construction in each. At least 12 additional cities were planning or designing light-rail systems. In 1995, 10 U.S. cities had commuter rail lines and all but one were planning, designing, or building extensions. At least eight more cities were planning or designing new commuter-rail systems.

Portland, Oregon

The light-rail system in the Portland metropolitan area opened in 1986 with a 15-mile line from downtown Portland east to the suburban community of Gresham. An 18-mile expansion is currently under construction from downtown Portland west through Beaverton and Hillsboro, both of which are part of the LUTRAQ study area. A third line extending south and north of downtown is being planned.

Land-use planning in the region now concentrates new development near light rail lines. Plans for westside station areas incorporate many of the concepts included in the LUTRAQ alternative.

Busways

Ottawa, Canada

Ottawa boasts one of the most successful transit systems in North America. The city's extensive busways provide service with the frequency and quality of many rapid rail systems. But the system has the flexibility to serve low-density residential neighborhoods with the same vehicles.

Busway service is frequent (three minutes in the peak, five minutes during the day) and fast (45 to 60 km per hour). With ridership at about 200,000 per day, sites adjacent to the busway are very attractive to developers. In fact, Ottawa's regional plan requires that large shopping centers and employment centers with 5,000 or more employees be located within a five-minute walk of busway stations.

Pittsburgh, Pennsylvania

Pittsburgh's busway system, which utilizes surplus railroad properties, has two lines operating and a third under construction. The 6.8-mile Martin Luther King Jr. Busway opened in 1983. A trip the length of the busway takes 10 to 15 minutes compared to 52 minutes for a parallel route on city streets. Ridership is equally divided between people who board at busway stations and those who board non-stop buses to downtown from neighborhood stops.

Bicycling and walking

Davis, California

Bicycles are used for about one-fourth of all commute trips in Davis. While students and employees at University of California-Davis do much of the pedaling, 7 percent of private sector workers use bicycles as their primary mode of commuting. The city and the university encourage bicycle use with an extensive linked network of bike lanes, active enforcement of motor vehicle and bicycle laws, and policies that limit cars on campus.

Minneapolis–St. Paul, Minnesota

The Twin Cities are developing bicycle expressways on abandoned railroad rights-of-way. These expressways provide barrier-free commuting routes that are separated from vehicle traffic. The University of Minnesota, which has 60,000 daily commuters, is developing expressway connections and additional bicycle facilities on its two campuses in an effort to increase bicycle commuting from 5 percent to 20 percent by 2000 (8 percent in winter).

Boulder, Colorado

Walking and bicycling are transportation priorities in Boulder. The city's two popular pedestrian facilities, the Boulder Creek multi-use path and the Downtown Pearl Street Pedestrian Mall, enjoy heavy use. The city's transportation plan includes projects to make the pedestrian environment safer and more convenient and comfortable. This includes a program to bring all sidewalks up to code and create pedestrian-oriented transit facilities.

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Pricing Road Use

Congestion pricing

Pricing road use relative to demand is a transportation management strategy being more widely considered. By charging drivers more during peak travel periods, this approach has the potential to impact a number of problems related to congestion, including:

- Overuse of highways
- Excessive travel delays
- Air pollution
- Excessive fuel and resource consumption
- Transit and carpool handicaps
- Inefficient investment in roadway capacity
- Sprawling, auto-based development

Advances in Automatic Vehicle Identification (AVI) systems have provided the collection technology necessary to implement detailed road pricing. Electronic AVI systems use wayside detectors to "read" electronic tags on passing vehicles. Road use charges can then be determined by type of vehicle, time of day, miles traveled, and even weight or length.

In the western United States, Boulder, Seattle, Portland, San Francisco, and Los Angeles have completed or are conducting road pricing studies. Because of its potential benefits, many policymakers are considering how to implement road pricing despite controversy and setbacks. Internationally, road pricing implemented in Singapore, Hong Kong, and Norway has reduced congestion as expected. After years of discussion, the first U.S. road pricing demonstration has been launched on SR-91 in Southern California. AVI systems are now located on SR-91 and will be in place on nine San Francisco Bay Area bridges. AVI systems also operate in some Norwegian cities, and Singapore is using them to automate region-wide variable road pricing without toll gates.

Alternatives to congestion pricing

Some transportation planners recommend pricing measures based on vehicle use or ownership when congestion pricing is not feasible. Frequently suggested vehicle use-based measures include:

- **Parking charges**. Raising parking prices within congested corridors can achieve some of the same effects of road pricing.

CQ535

- **VMT charges.** The notion of a flat charge per mile traveled has gained popularity as a long-term replacement for motor fuel taxes.

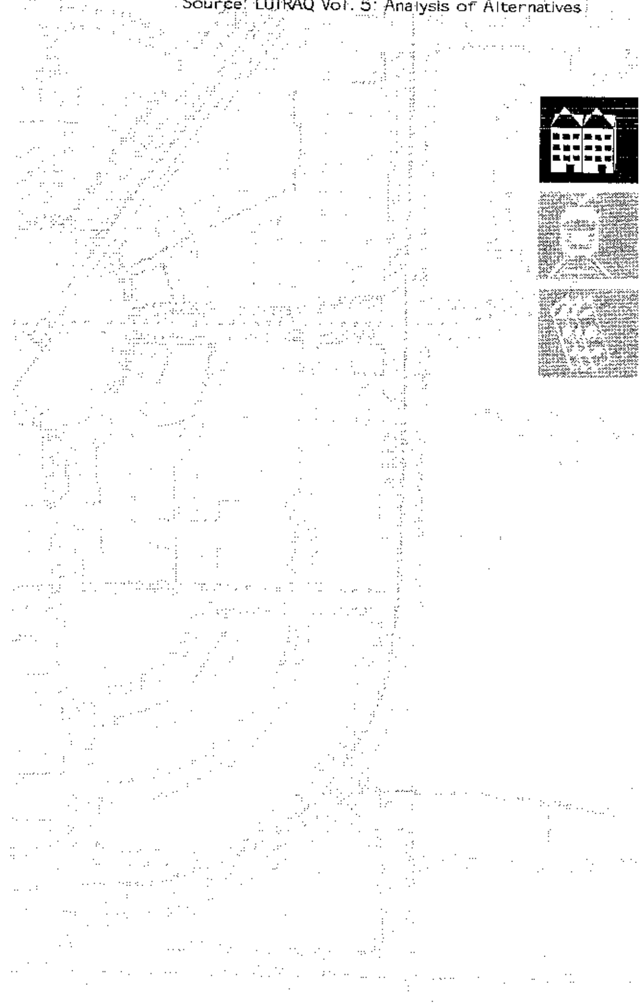
The LUTRAQ project modeled both a parking charge and an approximation of congestion pricing. In the parking charge scenario, parking was priced at $3 per day for commuters who drive to work alone. This component was included in the LUTRAQ alternative, paired with a transit pass subsidy. Together, these two pricing instruments roughly doubled the transportation impacts of LUTRAQ's transit-oriented developments, having approximately the same impact as the alternative development pattern.

Transportation Impacts Of Congestion Pricing

	No Build	LUTRAQ	LUTRAQ w/ Congestion Pricing	LUTRAQ w/ Congestion Pricing (TOD Areas Only)
Work Trip Mode Choice:				
Walk/Bike	2.8%	3.5%	4%	5.7%
Transit	7.5%	18.2%	21.1%	32.1%
Carpool	14%	20.1%	19.6%	16.4%
Drive Alone	75.8%	58.2%	55.3%	45.7%
Vehicle Trips/Household	7.53	7.17	7.07	5.67
Vehicle Hours of Delay (compared to No Build)	-	-53.2%	-65.9%	
Vehicle Miles Traveled (compared to No Build)	-	-6.4%	-13.2%	

Source: LUTRAQ Vol. 5: Analysis of Alternatives

The congestion pricing scenario added to the LUTRAQ alternative a charge of 15 cents per mile for auto trips made to and from work. This option focused the road pricing charge on vehicles that contribute most of the congestion costs, but did not vary the charge by the roads used. In spite of this limitation, congestion pricing resulted in the largest reduction in vehicle delay and the largest increase in non-auto trips of all the alternatives tested.



New Forms Of Land Development

In response to sprawling suburban development, some designers and planners have suggested new development patterns that draw on styles common in neighborhoods of the early 1900s. These patterns incorporate mixed uses, higher commercial and residential densities, an orientation to transit access, a network of interconnected, pedestrian-friendly streets, and an emphasis on public spaces. The following four communities reflect these ideas.[3]

Fairview Village

Fairview Village is an 88-acre development under construction in the eastern suburbs of the Portland, Oregon metropolitan area. When complete, the village will encompass 600 residential units, 150,000 square feet of retail space, 70,000 square feet of office space, and 15 acres of parks. The vil-

[3] This section focuses on what these new developments look like. An earlier LUTRAQ report, Vol. 3A: *Market Conditions*, forecasted potential market acceptance for this type of development in the Portland area. Since that report was published, these and other similar developments have been built and absorbed into the market at different rates.

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lage is designed to attract a diverse community of varying ages and economic statuses. It incorporates a range of housing types and sizes, public spaces, a continuous network of walkways and streets, and a blend of housing, shops, offices, and institutions. Every portion of the village is within a five-minute walk of the core commercial area.

Because existing city zoning codes did not allow for mixed uses and other village features, the developer convinced the city to adopt an entirely new code and a set of design guidelines specifically for the village. These guidelines reflect the craftsman traditions of the 1890s to 1940s and specify roof pitches, chimney materials, window type, and ceiling height. Garages must have rear alley access or be set back from the front facade. Streets are designed to slow traffic, provide an attractive space for pedestrians, connect to other parts of the village, and terminate in a public space, such as a small park or a civic structure. When complete, the village will be completely integrated with the surrounding developed area and will be the location of the Fairview city hall and the local post office.

Fairview Village was designed by William L. Dennis, town architect, and Lennertz, Coyle & Associates, town planners.

The Kentlands

The Kentlands is a 342-acre community in Gaithersburg, Maryland, a suburb of Washington, D.C. The Kentlands is designed for a population of 5,000, with a mix of 1,600 residential units, more than 1 million square feet of retail, 1 million square feet of office space, and 64 acres of open space. Plans for the mixed-use town center include apartments and offices above ground-floor retail. Residences include single-family detached units, carriage houses, townhouses, and apartments. The community includes schools, a library, recreation areas, and open space. Construction began in 1989, and the project was reported to be 75 percent complete in 1996.

Design codes regulate construction materials and design elements used within the community. Residences are oriented to the street with shallow setbacks and front porches. Residential parking is provided on the street or in alley garages, and office parking is provided at the side, rear, or below buildings.

The Kentlands was designed by Andres Duany and Elizabeth Plater-Zyberk.

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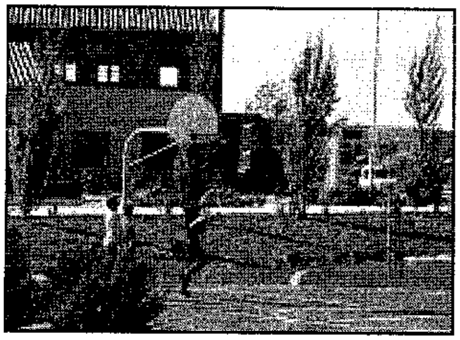
Laguna West

Laguna West is a 1,045-acre planned community in the Sacramento, California metropolitan area. The community is centered around a transit plaza and a 100-acre mixed-use town center with civic, retail, and commercial uses, as well as townhomes and apartments. Although retail development has been slow, the town center includes a town hall and an Apple Computer facility that employs 1,350 people.



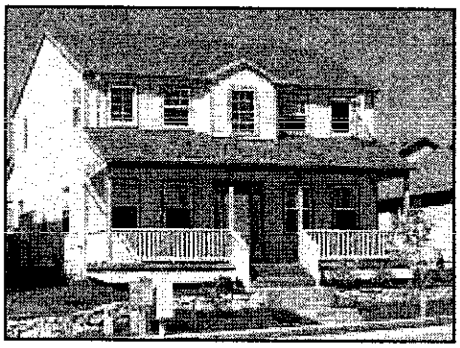
The town center uses a rectilinear street pattern, with curvilinear and cul-de-sac streets in the surrounding residential areas. The street network is designed to provide many connections within the community, with wide walkways and street trees to invite walking.

Design guidelines for residential structures require garages to be recessed at least five feet behind buildings. Porches, front entrances, and setbacks of 12 to 15 feet integrate homes to the streets, provide a safer pedestrian environment, and help create a sense of community. When the community is fully developed, it should have 3,370 residential units.

The community was planned by Calthorpe Associates.

Sunnyside Village

Sunnyside Village is a 368-acre development under construction at the eastern edge of Portland's urban growth boundary in Clackamas County. The village is centered around a 10-acre core of retail and public services with a transit stop. A village green and civic facilities will be located adjacent to this commercial core, with neighborhood parks scattered throughout the village. Residential areas will include apartments, townhomes, and small-lot single-family residences.



Residential areas are linked to the commercial core by a system of interconnected streets that are narrow and tree-lined to encourage walking. Open spaces will be connected by trails and bike paths. Steep slopes, wooded areas, and riparian corridors will be preserved.

Design guidelines require traditional design throughout the village. Single-family residences are required to have front porches and detached garages or attached garages that are set back from the front of buildings. Small retail shops will have street entrances and display windows along pedestrian connections. Apartments may be built above retail uses.

Clackamas County commissioned Calthorpe Associates to develop the Sunnyside Village plan and design guidelines.

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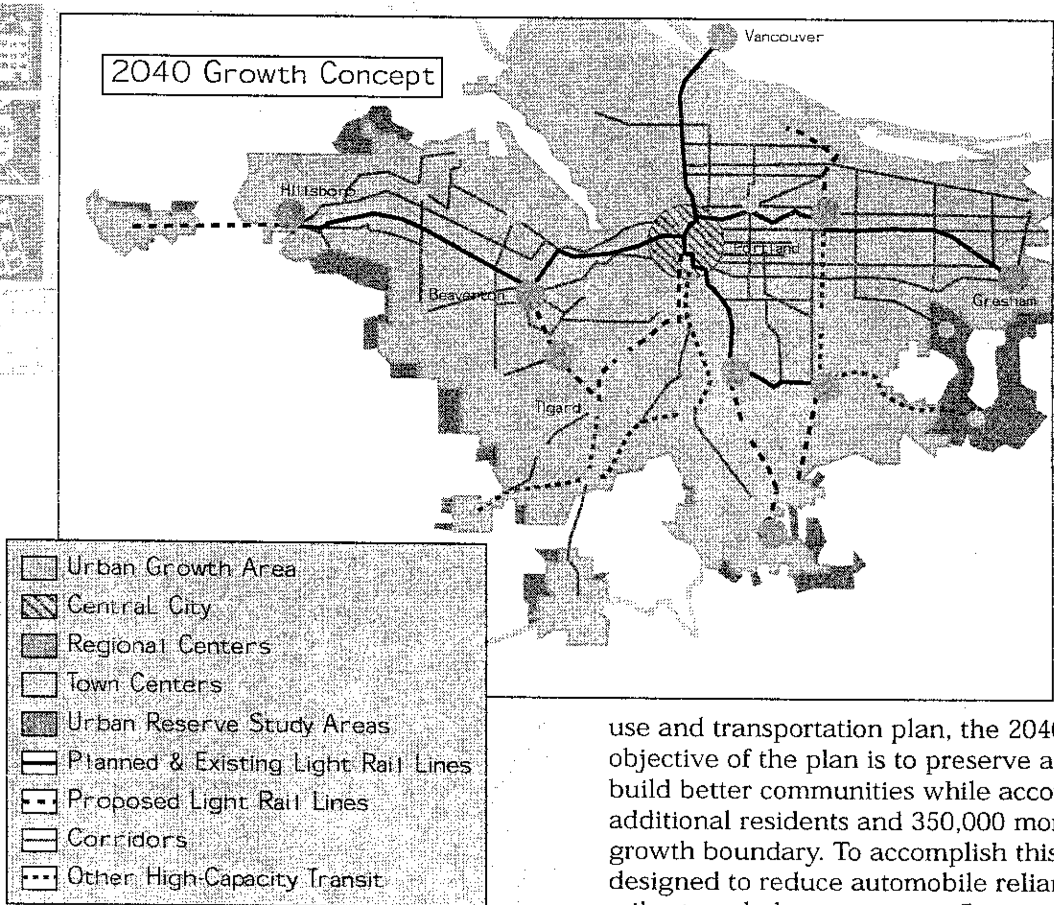
Regional Planning

Most large metropolitan areas encompass multiple jurisdictions, each with its own cast of elected officials, citizens groups, planners, developers, regulators, and business interests. Creating a chorus from so many disparate voices is the challenge more regions face as they address the need for comprehensive planning. A number of communities are demonstrating that local governments can, indeed, work together to integrate land-use and transportation planning. While approaches vary, the common thread from region to region is often a strong sense of regionalism and a commitment to cooperation.

Portland, Oregon

In the Portland metropolitan area, responsibility for regional planning rests with Metro, the only directly elected regional government in the country. Oregon law gives Metro authority to develop and implement regional tranportation and land-use plans for the three counties and 24 cities in the region. In practice, however, the agency has worked in partnership with local governments and other agencies to build consensus on how growth will be managed.



Metro has moved cautiously and incrementally since 1991 to develop and adopt regional land-use goals and objectives and its 50-year land-use and transportation plan, the 2040 Growth Concept. The objective of the plan is to preserve access to nature and build better communities while accommodating 720,000 additional residents and 350,000 more jobs within the urban growth boundary. To accomplish this, the growth concept is designed to reduce automobile reliance, decreasing vehicle miles traveled per person to 5 percent below 1990 levels.

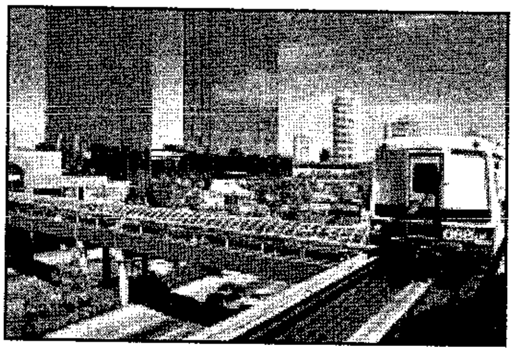
The agency is now working with local governments to develop individual functional plans for implementation. The Metro Council, whose seven members are elected from districts within the region, has approval authority for regional plans. However, those plans are the result of an exhaustive review process that includes local government and citizen advisory committees and broad-based public involvement programs.

Seattle, Washington

While local governments planted the seeds of regional planning in the Seattle area, they took root because of state legislation. Under the direction of the local council of governments, the four-county Seattle metropolitan area developed a vision for land use and transportation, Vision 2020. Though it lacked enforcement authority, Vision 2020 was in the right place at the right time when Washington State passed its Growth Management Act, which requires comprehensive local planning. Local governments now look to Vision 2020 as a framework for local planning.

The state has created transportation planning incentives as well. It has required large employers to develop trip reduction programs, authorized creation of the Regional Transit Authority to encourage coordinated transit planning, and solicited private-sector proposals to manage portions of the state highway system, which has led to road pricing proposals. The state now also requires "least-cost planning" to evaluate transportation options.

Vancouver, British Columbia



In 1966, the provincial government of British Columbia created the Greater Vancouver Regional District (GVRD) to provide regional planning and manage water, sewer, garbage, air quality, and other regional services. In 1975, the GVRD developed a Livable Region Plan that focused development around regional town centers linked with high-capacity transit. The plan, developed with extensive participation of citizens, enjoyed widespread support among GVRD member agencies. Although friction between the GVRD and the provincial government caused the agency's land-use and transit planning authority to be revoked in 1983, the GVRD worked with local governments to update the plan in 1990.

The local ordinances enacted to carry out the plan demonstrate the level of local support. The region now has an advanced rail system (SkyTrain) and a high speed passenger ferry (SeaBus) that connect five of seven thriving regional centers. Economic development programs, zoning ordinances, and the location of government offices support development of the centers.

Minneapolis–St. Paul, Minnesota

In 1967, the Minnesota legislature created the Metropolitan Council to plan and coordinate services for the Twin Cities area. The council, whose members are appointed by the legislature, works closely with local governments, the state legislature, and state agencies to shape development for the area, which is comprised of seven counties and 189 municipalities.

The Council adopted a 1975 urban service boundary that identifies areas where services such as water and sewer will be provided. As a result, urban development has occurred primarily inside the urban service area or in rural centers, and land outside the urban service boundaries has been largely preserved for agriculture. The Metropolitan Council is now working to determine future growth patterns, changes in the urban service boundary location, and infrastructure investments.

Grassroots Involvement

From the 1950s through the 1970s, the heyday of the U.S. interstate highway construction program, citizens had little influence on transportation projects. In recent years, however, the highway monopoly has begun to recede, and citizens groups are demanding input, with some notable successes.

Virginia

A coalition of Virginia citizens groups joined several developers to oppose a new bridge over the James River. The bridge, which was to be located adjacent to Jamestown, would have replaced existing ferry service and opened up large tracts of land to suburban sprawl, all at the expense of one of the nation's most important historical sites. The coalition undertook a technical analysis of the bridge proposal and lobbied the state transportation board and the local metropolitan planning organization to scrap the bridge idea. By the end of 1991, the bridge project was put to rest. The area now enjoys expanded ferry service and a landscape that has remained relatively unchanged since the first English colonists arrived in 1607.

Washington, D.C.

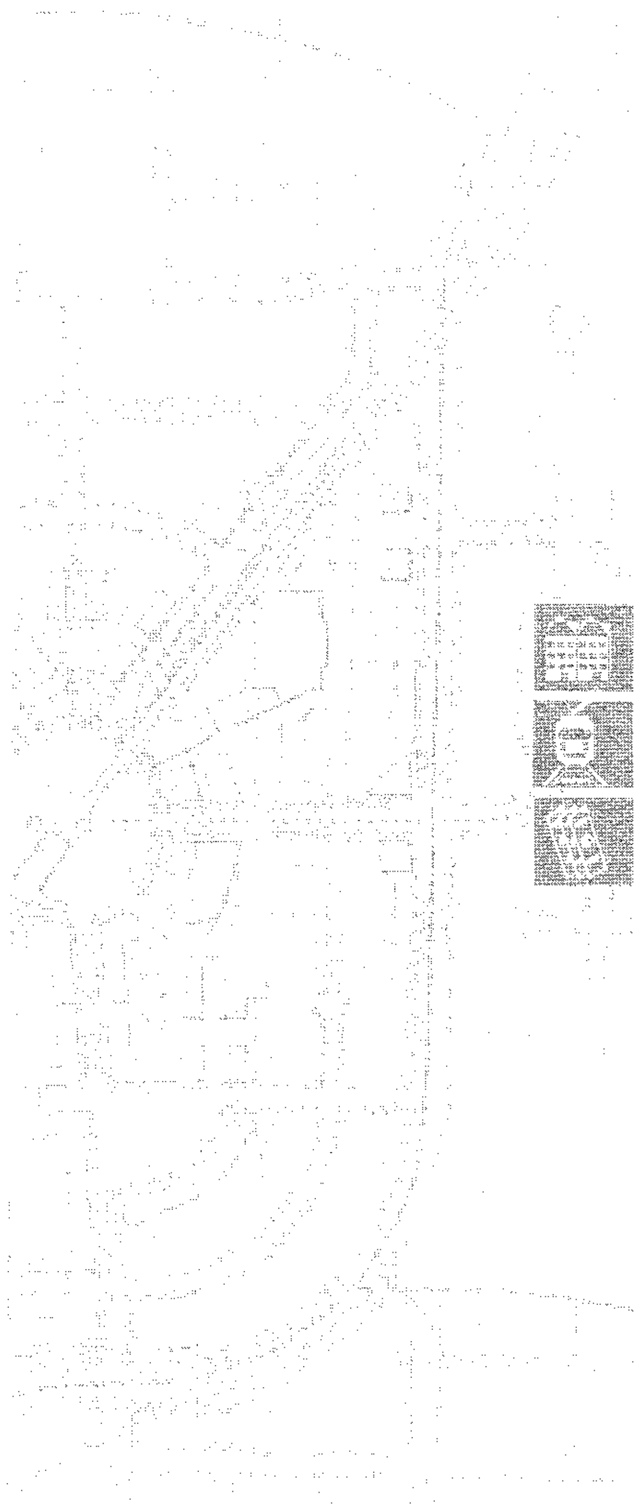
A citizens-based technical analysis was also instrumental in halting consideration of a bypass around Washington, D.C. The analysis, prepared by the Chesapeake Bay Foundation (CBF), showed that the highway would have put 1.1 million acres of open land at risk to sprawl development, with substantial impacts on Chesapeake Bay and the environment. CBF worked with the Chesapeake Bay Commission to remove the bypass from consideration and to institute a new planning process for the existing US 301 corridor with the Maryland Department of Transportation. Using a broad-based task force of citizens, organizations, and public agencies, the US 301 planning effort has sought to integrate land use, open space, urban design, and environmental issues into transportation planning procedures.

Connecticut

When the Connecticut Department of Transportation proposed widening the historic Merrit Parkway in 1990, the Connecticut Trust for Historic Preservation organized citizen opposition. The parkway, which was completed in 1941, was designed to provide a leisurely park-like setting for motorists traveling between New York state and New England. As originally constructed, the parkway featured landscape design by Thayer Chase and art deco bridges. In 1991, the Connecticut Department of Transportation announced that the 50-year-old parkway would not be widened after all. The parkway is now listed on the National Register of Historic Places.

Georgia

The Georgia Department of Transportation was not nearly as accommodating, at least initially, in the case of a four-lane freeway proposed in Atlanta. The Presidential Parkway would have covered several parks in central portions of Atlanta, including three designed by Frederick Law Olmsted. Neighborhood associations in the eight districts that would have been bisected by the Parkway formed a coalition to oppose the project. The transportation department refused to discuss the project despite six years of litigation and a court order to mediate. In 1991, mediation talks finally were held. The result: a 2.1 mile meandering two-lane surface street, designed according Olmsted principles, with low speed limits and bike lanes at one-third the price of the freeway proposal.



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ACKNOWLEDGMENTS

About 1000 Friends of Oregon

1000 Friends of Oregon was founded in 1975 as a non-profit public service organization. It conducts research and public education on land-use and growth-management issues, and provides legal advice, technical assistance, and advocacy on planning policies at state and local levels. Executive Director: Robert L. Liberty

For more information about the LUTRAQ project and 1000 Friends of Oregon, contact:

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About Sensible Transportation Options for People

Sensible Transportation Options for People (STOP) is a grassroots citizens organization formed in 1989 to oppose the Western Bypass freeway and promote better transportation options. In 1992, STOP expanded its focus to include educating the general public and elected leaders about LUTRAQ. STOP fulfills its mission to support transportation systems that foster livable communities by participating on regional transportation committees, providing traffic calming resources to communities struggling with traffic problems, and promoting LUTRAQ principles nationally. Executive Director: Meeky Blizzard

For information about STOP, contact:

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1000 Friends of Oregon

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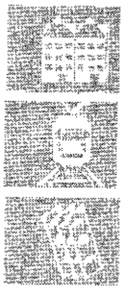
Policy Advisory Committee



Meeky Blizzard, Sensible Transportation Options for People

William Blosser, Chair, Oregon Land Conservation and Development Commission

Earl Blumenauer, U.S. Representative, Third District, Oregon

Rex Burkholder, Bicycle Transportation Alliance

Jane Cease, Oregon Department of Transportation

John Charles, Consultant

Michael Hollern, Brooks Resources

Jim Howell, Citizens for Better Transit

Vera Katz, Mayor, City of Portland

Patricia Kliewer, Citizen Participation Organization #10, Washington County, Oregon

Susan McLain, Metro Councilor

Gussie McRobert, Mayor, City of Gresham

Linda Peters, Chair, Washington County Board of Commissioners

John Russell, President, Russell Development Company

James Standring, President, Westland Industries, Inc.

Thomas Walsh, General Manager, Tri-County Metropolitan Transportation District of Oregon

Local Technical Advisory Committee

G.B. Arrington, Director of Long Range and Strategic Planning, Tri-County Metropolitan Transportation District of Oregon

Robert Branan, Parsons Brinckerhoff Quade & Douglas, Inc.

Jon Chandler, Oregon Building Industry Association

Robert Cortright, Transportation and Land Use Planner, Oregon Department of Land Conservation and Development

Andy Cotugno, Transportation Director, Metro

Brent Curtis, Planning Manager, Washington County Department of Land Use and Transportation

Steve Dotterrer, Chief Transportation Planner, City of Portland

Kenneth J. Dueker, Director, Center for Urban Studies, Portland State University

Barrow Emerson, Senior Transportation Planner, OTAK

Brian Gregor, Senior Transportation Planner, Oregon Department of Transportation

Keith Lawton, Assistant Director of Technical Services, Metro

Doug McClain, Land Use and Planning Manager, Clackamas County

Scott Pemble, Transportation Planner, Multnomah County

Robin McArthur-Phillips, Advisor to the Governor on Transportation and Growth Management

Sam Sadler, Energy Analyst, Oregon Department of Energy

Ethan Seltzer, Director, Institute for Portland Metropolitan Studies, Portland State University

Theodore Spence, Consultant

Robert E. Stacey Jr., Ball, Janik & Novack

Ron Weinman, Principal Transportation Planner, Clackamas County

Mike Wert, Principal, W & H Pacific

Project Team

Parsons Brinckerhoff Quade & Douglas, Inc.

Parsons Brinckerhoff Quade & Douglas is the leading provider of transit planning and design services in the United States. The firm has been involved in more than 75 percent of the nation's light rail transit systems in operation or under construction today. The firm's architects have developed concepts for or designed over 200 transit stations in the last 10 years.

Samuel Seskin, lead planner for the firm's Portland, Oregon office, has been the overall technical manager for the LUTRAQ project team. Dr. Judy Davis, Stamatia Petsios, Brent Baker, Cathy Strombom, and Youssef Dehghani worked on the team.

Calthorpe Associates

Calthorpe Associates is known nationally for its innovative work in the design of mixed-used, pedestrian-oriented developments and communities. Projects and plans emphasize amenities for pedestrians which, in combination with the creative development of local street patterns, afford an opportunity to improve local quality of life and reduce traffic congestion.

Key staff for the LUTRAQ project were Peter Calthorpe, Shelley Poticha, and Phil Erickson.

ECONorthwest

ECONorthwest was founded in 1974 and has offices in Eugene, Portland, and Seattle. ECO is an economic consulting firm specializing in development economics, resource economics, planning and public policy, management, finance and banking, and litigation support. ECO has over 20 years experience in advising state and federal agencies, municipalities, service agencies, and private clients in natural resource management and evaluation of public policies, facilities, and services.

Terry Moore, from the firm's Eugene office, participated on the LUTRAQ team, providing management and writing services for the project's final phases, including production of this booklet.

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Cambridge Systematics, Inc.

Cambridge Systematics provides planning and management services in the areas of transportation management information systems, economic development, energy, and telecommunications. Since its formation in 1972, the firm has gained a national reputation for applying state-of-the-art analytic techniques to complex problems, and for developing innovative, practical solutions for clients.

Thomas Rossi, Arlee Reno, Robert Lepore, Earl Ruiter, John Suhrbier, and Sam Lawton participated on the LUTRAQ team.

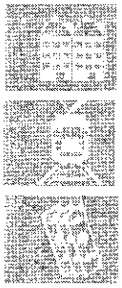
S.H.Putman Associates

S.H.Putman Associates licenses the Integrated Transportation and Land Use Package (ITLUP), the most widely used land-use model system in the United States.

Key staff working with the LUTRAQ project team were Dr. Steven H. Putman and David Stiff.

Michel Gregory Communications

Michel Gregory Communications specializes in environmental and public service communications in the Pacific Northwest. The firm offers a range of services, including communication strategy development and implementation, writing and editing, media relations, and public education campaign creation and management.



Michel Gregory provided writing and editing services for this booklet.

CircleTriangleSquare

CircleTriangleSquare is a design studio experienced in all aspects of graphic design, technical and product illustration, print production, and project management. With clients ranging from start-up companies to large corporations, the firm specializes in product catalogues, corporate identity materials, logo and collateral development, and special events materials.

Partner Heather Barta designed this booklet for the LUTRAQ project.

Craig Holmes Illustration

Craig S. Holmes is an illustrator/designer working with architects, engineers, and other design and communication professionals to picture their visions. The cover art for this report was designed specifically for the LUTRAQ project.

Market Perspectives

Market Perspectives is a residential and commercial real estate consulting firm based in Sacramento, California specializing in analyzing competitive markets, product positioning and marketing strategies, and feasibility/absorption studies. The firm's clientele includes such well-known developers as Grupe Development, The Sammis Company, Taylor Woodrow Homes, Kaufman & Broad, McDonald's Corporation, and Pacific Gas and Electric Company.

Founder and President John Schleimer participated on the project team.

Hébert/Smolkin Associates, Inc.

Hébert/Smoklin Associates, Inc. consults with developers, lenders and investors in real estate market analysis throughout the United States. The firm, with offices in Palo Alto, California and New Orleans, Louisiana, specializes in market and economic feasibility studies for both commercial and residential developments.

The company's founder, John Hébert, worked on the LUTRAQ project team.

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Hague Consulting Group

Hague Consulting Group, located in The Hague, Netherlands, is known for its application of travel demand forecasting models worldwide. In The Netherlands, the firm is participating in a national transportation plan, applying an integrated land-use model and other analytic tools to predict travel demand.

Hugh Gunn participated on the LUTRAQ project team.

Gardiner & Clancy, LLC

Gardiner & Clancy serves as financial counsel to governments, non-profits, and public-private ventures in the Pacific Northwest. The firm provides access to a wide range of financial management, analysis, and strategy services, as well as the full spectrum of credit market relations and asset and liability management services. The professionals at Gardiner & Clancy have more than 50 years of combined experience in public finance.

Mark Gardiner worked on the LUTRAQ team.

Blayney Dyett

Blayney Dyett is a California-based consulting firm with broad zoning experience throughout the West. About 90 percent of the firm's work is for local governments and other public agencies. The firm worked on the Portland Downtown Plan, which received a HUD Honor Award, and the Portland Westside Transit Study.

Michael Dyett worked with the LUTRAQ project team.

REFERENCES

American Farmland Trust. *Alternatives for Future Urban Growth In California's Central Valley: The Bottom Line for Agriculture and Taxpayers.* Washington, DC: American Farmland Trust, 1995.

American Public Works Association. *Improving the Quality of Life Through Public Works.* Kansas City, MO: American Public Works Association, 1996. http://www.pubworks.org/roads.html.

"Are TNDs Selling?," *Builder Magazine*, August 1993.

Arrington, G.B. *Beyond the Field of Dreams.* Portland, OR: Tri-Met, 1996.

Bank of America, Greenbelt Alliance, California Resources Agency, and Low Income Housing Fund. *Beyond Sprawl: New Patterns of Growth to Fit the New California.* San Francisco: Bank of America, 1995.

Burchell, Robert W. and David Listokin. "Land, Infrastructure, Housing Costs, and Fiscal Impacts Associated with Growth: The Literature on the Impacts of Traditional versus Managed Growth." Presented at the Alternatives to Sprawl Conference, Washington DC, March 22, 1995.

Bureau of Transportation Statistics. *Transportation Statistics Annual Report 1994.* Washington, DC: U.S. Department of Transportation, 1994.

Calthorpe Associates, Leland Consulting Group, and Tashman Associates. *East Sunnyside Village Plan.* Oregon City, OR: Clackamas County Department of Transportation & Development, 1993.

Calthorpe, Peter. *The Next American Metropolis: Ecology, Community, and the American Dream.* New York: Princeton Architectural Press, 1993.

Carlson, Daniel, Lisa Wormser and Cy Ulberg. *At Road's End: Transportation and Land Use Choices for Communities.* Washington, DC: Island Press, 1995.

Christoforidis, Alexander. "New Alternatives to the Suburb: Neo-traditional Developments," *Journal of Planning Literature*, 8 (4), 1994.

Cox, Wendell. *Demographic Briefs: US Urbanized Area Population & Density Trends: 1950-1990.* Belleville, IL: Wendell Cox Consultancy, 1996. www.publicpurpose.com/inf-usua.htm.

Deakin, Elizabeth. "Growth Controls and Growth Management: A Summary and Review of Empirical Research," *Understanding Growth Management: Critical Issues and a Research Agenda.* Washington DC: Urban Land Institute, 1989.

"Divided We Sprawl," *Kansas City Star*, December 17-22, 1995.

ECONorthwest. *Evaluation of No-Growth and Slow-Growth Policies for the Portland Region.* Eugene, OR: ECONorthwest, 1994.

Federal Highway Administration. *Highway Statistics 1989.* Washington, DC: U.S. Department of Transportation, 1990.

-----. *Highway Statistics 1994.* Washington, DC: U.S. Department of Transportation, 1995.

-----. *National Personal Transportation Survey.* Washington DC: U.S. Department of Transportation, 1993.

Holt and Haugh. *Fairview Village Booklet.* Portland, OR: Holt and Haugh.

Kelbaugh, Doug. *The Pedestrian Pocket Book.* New York: Princeton Architectural Press, 1989.

Lane Council of Governments. *Transportation-Efficient Development.* Eugene, OR: Lane Council of Governments, May 1996.

Myers, Dowall. "Internal Monitoring of Quality of Life for Economic Development," *Economic Development Quarterly*, 1 (3), 1987, 268-278.

Northeastern Illinois Planning Commission. *1990 Land Use in Northeastern Illinois Counties, Minor Civil Divisions and Chicago Community Areas.* Chicago: NIPC, 1995.

1000 Friends of Oregon. *Making the Land Use, Transportation, Air Quality Connection.* Portland, OR: 1000 Friends of Oregon:

Vol. 1, Modeling Practices. 1991.

Vol. 2, Existing Conditions. 1991.

Vol. 3, The LUTRAQ Alternative. 1992.

Vol. 3A, Market Research. 1992.

Vol. 4, Model Modifications. 1996.

Vol. 4A, The Pedestrian Environment. 1993.

Vol. 4B, Building Orientation. 1994.

Vol. 5, Analysis of Alternatives. 1996.

Vol. 6, Implementation. 1995.

Vol. 8, Making the Connections: Technical Report. 1997.

Site Design and Travel Behavior: A Bibliography. 1993.

Oregon Department of Transportation. *Western Bypass Study Alternatives Analysis.* Portland, OR: Oregon Department of Transportation, 1995.

Pisarski, Alan. *New Perspectives in Commuting.* Washington, DC: Federal Highway Administration, Office of Highway Information Management, July 1992.

Rusk, David. *Cities Without Suburbs.* Washington, D.C.: The Woodrow Wilson Center Press, 1993.

Urban Land Institute. "Laguna West, Sacramento, California." *Project Reference File*, 24 (11), 1994.

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OC Transpo: page 19

Gordon Price: page 25

TITLE PAGE

MAKING THE CONNECTIONS

A summary of the LUTRAQ project

Volume 7

Integrating land-use and transportation planning
for livable communities

Produced by 1000 Friends of Oregon
February 1997

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References

Association of Bay Area Governments. 1991. *Assessing the Future: A Sensitivity Analysis of Highway and Road Improvements on Growth in the San Francisco Bay Area.* Working Paper 91-4. Oakland, CA: ABAG.

Beimborn, Edward and Rob Kennedy. 1996. *Inside the Blackbox: Making Transportation Models Work for Livable Communities.* Milwaukee, WI: Citizens for a Better Environment.

Carlson, Dan, Lisa Wormser and Cy Ulberg. 1995. *At Road's End: Transportation and Land Use Choices for Communities.* Washington, D.C.: Island Press.

Cambridge Systematics. 1994. *The Effects of Land Use and Travel Demand Strategies on Commuting Behavior.* Washington, DC: Federal Highway Administration.

Cervero, Robert. 1995. "Sustainable New Towns: Stockholm's Rail-Served Satellites." *Cities,* vol. 12 (1), pp. 41-51.

Cervero, Robert and Samuel Seskin. 1995. *An Evaluation of the Relationship Between Transit and Urban Form.* Transit Cooperative Research Program Research Results Digest, no. 7. Washington, DC: Transportation Research Board.

Clinton, William and Albert Gore, Jr. 1993. *The Climate Change Action Plan.* Washington, DC: The White House.

Deakin, Elizabeth. 1994. "Urban Transportation Congestion Pricing: Effects on Urban Form." In *Curbing Gridlock: Peak-Period Fees To Relieve Traffic Congestion.* Transportation Research Board Special Report 242, vol. 2, pp. 334-355. Washington, DC: National Academy Press.

Delucchi, Mark. 1996. *The Annualized Social Cost of Motor-Vehicle Use in the United States.* Davis, CA: University of California.

Downs, Anthony. 1982. "How Transportation Arteries Impact Land Value." In *Urban Transportation: Perspectives and Prospects,* edited by H. S. Levinson and R. A. Weant, pp. 105-109. Westport CT: Eno Foundation.

ECONorthwest and Parsons Brinckerhoff Quade & Douglas. 1995. *Evaluation of Transportation Alternatives: Least-Cost Planning: Principles, Applications, and Issues.* Metropolitan Planning Technical Report, no. 6. Washington, DC: Federal Highway Administration.

ECO Northwest. 1994. *The Effects of Transportation Improvements on Rural Lands: A Framework for ODOT Policy.* Salem, OR: Oregon Department of Transportation.

Environmental Protection Agency. 1995a. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1994.* Washington DC: EPA.

Environmental Protection Agency. 1995b. *State Workbook: Methodologies for Estimating Greenhouse Gas Emissions.* Washington, DC: EPA.

Ewing, R., P. Haliyur, and G. W. Page. 1994. "Getting Around a Traditional City, A Suburban PUD, and Everything In-Between." Paper presented at the 73rd Annual Meeting of the Transportation Research Board, Washington, DC.

CQ535

Giuliano, Genevieve. 1995. "Land Use Impacts of Transportation Investments." In *The Geography of Urban Transportation,* 2nd ed., edited by Susan Hanson. New York: Guilford Press.

Handy, Susan. 1993. "Regional Versus Local Accessibility: Neo-Traditional Development and Its Implications for Non-Work Travel." *Built Environment,* vol. 18(4), pp. 253-267.

Hansen, Mark. 1995. "Do New Highways Generate Traffic?" *Access: Research at the University of California Transportation Center,* no.7. Berkeley, CA: University of California.

Hart, Tom. 1992. "Transport, The Urban Pattern and Regional Change, 1960-2010." *Urban Studies,* vol. 29(3-4), pp. 483-503.

Harvey, Greig. 1990. *Relation of Residential Density to VMT Per Resident.* Oakland, CA: Metropolitan Planning Commission.

Harvey, Greig and Elizabeth Deakin. 1993. *A Manual of Regional Transportation Modeling Practice for Air Quality Analysis.* Washington, DC: National Association of Regional Councils.

Holtzclaw, John. 1990. "Explaining Urban Density and Transit Impacts on Auto Use." Paper presented to the State of California Energy Resources Conservation and Development Commission by the Natural Resources Defense Council and the Sierra Club.

JHK and Associates, et al. 1993. *Analysis of Indirect Source Trip Activity at Regional Shopping Centers.* State of California Air Resources Board, report #A-132-094. Sacramento, CA: CARB.

Kessler, Jon and William Schroeer. 1993. *Meeting Mobility and Air Quality Goals: Strategies that Work.* Washington, DC: U.S. Environmental Protection Agency, Office of Policy Analysis.

Maryland National Capitol Planning Commission & Montgomery County Planning Department. 1989. *Comprehensive Growth Policy Study: A Policy Vision—Centers and Trails.* Silver Spring, MD: Montgomery County Planning Department.

Metro. 1994. *Region 2040 Recommended Alternative Decision Kit.* Portland, OR: Metro.

Metropolitan Council. 1995. *Alternative Growth Scenarios Definition.* St. Paul, MN: Metropolitan Council.

Mid-America Regional Council. 1993. *Metropolitan Kansas City's Urban Core: What's Occurring, Why It's Important and What We Can Do.* Kansas City, MO: MARC.

Moore, Terry and Paul Thorsnes. 1994. *The Transportation/Land Use Connection: A Framework for Practical Policy.* Planning Advisory Service Report, no. 448/449. Chicago, IL: American Planning Association.

Muller, Peter. 1981. *Contemporary Suburban America.* Edgewood Cliffs, NJ: Prentice-Hall.

National Cooperative Highway Research Program. 1996. *Integration of Land Use Planning with Multimodal Transportation Planning,* report 8-32(3). Washington, DC: Transportation Research Board.

Nelson\Nygaard Consulting Associates. 1995. "Land Use and Transit Demand: The Transit Orientation Index." In *Primary Transit Network Study,* chap. 3. Portland, OR: Tri-Met.

1000 Friends of Oregon. *Making the Land Use, Transportation, Air Quality Connection (LUTRAQ).* Portland, OR: 1000 Friends of Oregon.

Vol. 1, *Modeling Practices.* 1991a.

Vol. 2, *Existing Conditions.* 1991b.

Vol. 3, *The LUTRAQ Alternative.* 1992a.

Vol. 3A, *Market Conditions.* 1992b.

Vol. 4, *Model Modifications*. 1996a.

Vol. 4A, *The Pedestrian Environment*. 1993.

Vol. 4B, *Building Orientation*. 1994.

Vol. 5, *Analysis of Alternatives*. 1996b.

Vol. 6, *Implementation*. 1995.

Vol. 7, *Making the Connections: A Summary of the LUTRAQ Project*. 1997.

Oliver, G. 1994. "Portland Revs Up for Action." *Planning*, vol. 60(8), pp. 8-13.

Oregon Department of Transportation. 1994. *Western Bypass Study: Sunset Highway - Pacific Highway Air Quality Technical Report*. Portland, OR: ODOT.

Parsons Brinckerhoff Quade and Douglas. 1996a. *Transit Urban Form and the Building Environment: A Summary of Knowledge*. Transit and Urban Form, TCRP Report 16, vol. 1. Washington, DC: Transportation Research Board.

Parsons Brinckerhoff Quade and Douglas. 1996b. *Commuter and Light Rail Transit Corridors: The Land Use Connection*. Transit and Urban Form, TCRP Report 16, vol.1. Washington, DC: Transportation Research Board.

Parsons Brinckerhoff Quade and Douglas. 1996c. *Public Policy and Transit Oriented Development: Six International Case Studies*. Transit and Urban Form, TCRP Report 16, vol. 2. Washington, DC: Transportation Research Board.

Parsons Brinckerhoff Quade and Douglas. 1996d. *Influence of Land Use Mix and Neighborhood Design on Transit Demand*. TCRP Project H-1. Washington, DC: Transportation Research Board.

Parsons Brinckerhoff Quade and Douglas. 1996e. *A Guidebook for Practitioners*. Transit and Urban Form, TCRP Report 16, vol. 2. Washington, DC: Transportation Research Board.

Portland, City of. 1993. *Carbon Dioxide Reduction Strategy*. Portland, OR: City of Portland.

Post Buckley Schuh & Jernigan. 1995. *Tallahassee-Leon County Transportation Study: Model Validation and Year 2020 Transportation Plan*. Tallahassee, FL: Tallahassee-Leon County MPO.

Pushkarev, Boris and Jeff Zupan. 1977. *Public Transportation & Land Use Policy*. Bloomington, IN: Indiana University Press.

Southwest Pennsylvania Regional Planning Commission. 1994. *A Region on the Move: A Transportation Investment Strategy for Growth and Renewal in Southwest Pennsylvania (Technical Supplement)*. Pittsburgh, PA: Southwest Pennsylvania Regional Planning Commission.

Transportation Research Board. 1995. *Expanding Metropolitan Highways: Implications for Air Quality and Energy Use*. Special Report no. 245. Washington, DC: National Academy Press.

U.S. Department of Transportation. 1995. *Travel Model Improvement Program: Land Use Modeling Conference Proceedings*, February 19-21, 1995. Washington, DC: Technology Sharing Program, U.S. Department of Transportation

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Executive Summary

The first part of this report reviews what is known about the relationships between transportation and land use. These relationships work in both directions: the density, mix, and design of land uses influence travel patterns, and transportation investments influence development patterns. The second part presents a step-by-step approach to developing an integrated transportation and land-use plan.

What We Know About Land Use and Transportation

Recent research shows that urban form influences travel patterns. People who live in sprawling suburban areas make different transportation choices than those who live in more compact, pedestrian-friendly places. *Making the Land Use, Transportation, Air Quality Connection* (the LUTRAQ project) shows that locating planned moderate-density development near transit is likely to result in higher use of transit, walking, and bicycling than would normally be the case under more typical suburban development patterns. A national analysis of commuter- and light-rail corridors shows that ridership on these systems is dependent upon the density of employment in the central business district and density of residences in the corridors. Evaluations of mixed use and urban design demonstrate that these factors influence people's choice of travel modes.

Improvements in transportation systems have lowered the cost of transportation both within and between cities. Lower transportation costs have supported the dispersion of residents and jobs. At the same time, businesses have clustered at the most accessible and visible places in the regions—the crossroads of transportation routes. As a result, metropolitan areas have become polycentric regions with commuter sheds and markets that extend far into the countryside. Additions to the transportation system today do not have the same dramatic regional effects as the proliferation of the streetcar and the railroad at the turn of the twentieth century, or the automobile half a century later. Nonetheless, transportation improvements continue to influence urban form by supporting land-use changes in the corridors where travel is improved.

In sum, recent empirical research shows that integrating the planning of transportation and land use holds great promise for minimizing the adverse impacts of growth and development. These lessons can be applied to fast growing regions in the United States to produce development that is less dependent on the automobile.

How to Develop an Integrated Alternative

A step-by-step approach, common to many planning processes, was used to develop and evaluate the LUTRAQ alternative. Integrated transportation and land-use alternatives differ from standard alternatives in their goals and assumptions, and they may require some changes in models or analytical tools. However, the process of developing and evaluating these alternatives is similar to most planning processes.

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Clarify the scope of the project.

The LUTRAQ project was developed as an alternative for an Environmental Impact Statement/Major Investment Study. It challenged the idea that land uses must be held constant when addressing transportation needs. Other integrated alternatives have been developed in other metropolitan areas for growth management and regional transportation plans. The federal Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) is facilitating many of these efforts.

Decide who will be involved.

The LUTRAQ alternative was developed by non-profit advocacy groups working with governmental agencies. Other integrated plans have been led by state departments of transportation, cities, counties, metropolitan planning organizations, and other non-profit groups.

Define a range of alternatives.

The LUTRAQ alternative began with an inventory of existing land uses and an identification of trends. Then, integrated alternatives were developed and tested in an iterative process to understand better the types of changes in land use and transportation policy that would work together to reduce automobile dependence. Similarly, other projects have developed one or more alternatives that differ from current trends or address transportation needs with varying investments and policies.

Determine performance measures for comparing alternatives.

The LUTRAQ alternatives analysis focused on performance measures generated by a regional travel demand model, such as mode choice and daily vehicle miles of travel. Other projects have developed performance measures that are consistent with the goals of those projects and the ability of available technical tools to measure the desired characteristics.

Select analytical tools for analyzing alternatives.

The LUTRAQ project team worked with Metro, the Portland-area regional government, to improve the agency's travel demand model so that it would be more sensitive to the pedestrian environment and the mix and density of uses. Efforts to link travel-demand and land-use models were not successful. Other projects have developed or applied land-use models or created innovative uses of qualitative and quantitative tools.

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Simulate alternatives and interpret results.

The LUTRAQ analysis showed that an integrated land-use/transportation/demand-management alternative was more successful at meeting the transportation needs of the study area than just building highways. Results from other studies have similarly assisted regions in deciding how to grow and how best to invest transportation resources.

Implement the preferred alternative.

The LUTRAQ alternative is being implemented—in content, if not in name—by the Portland-area regional government (Metro) through its regional growth-management process. In December 1994, Metro adopted the Region 2040 Growth Concept, a regional land-use/transportation plan that incorporates many of the LUTRAQ concepts. In November 1996, Metro adopted a Functional Plan to require that cities and counties change their comprehensive plans and zoning ordinances to comply with the Growth Concept. In addition, Metro is working on its regional transportation plan which will also implement the Growth Concept. Other regions are also adopting policies to limit the extent of urban areas and to focus growth into transit-served locations.

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To: ceq_nepa@fs.fed.us
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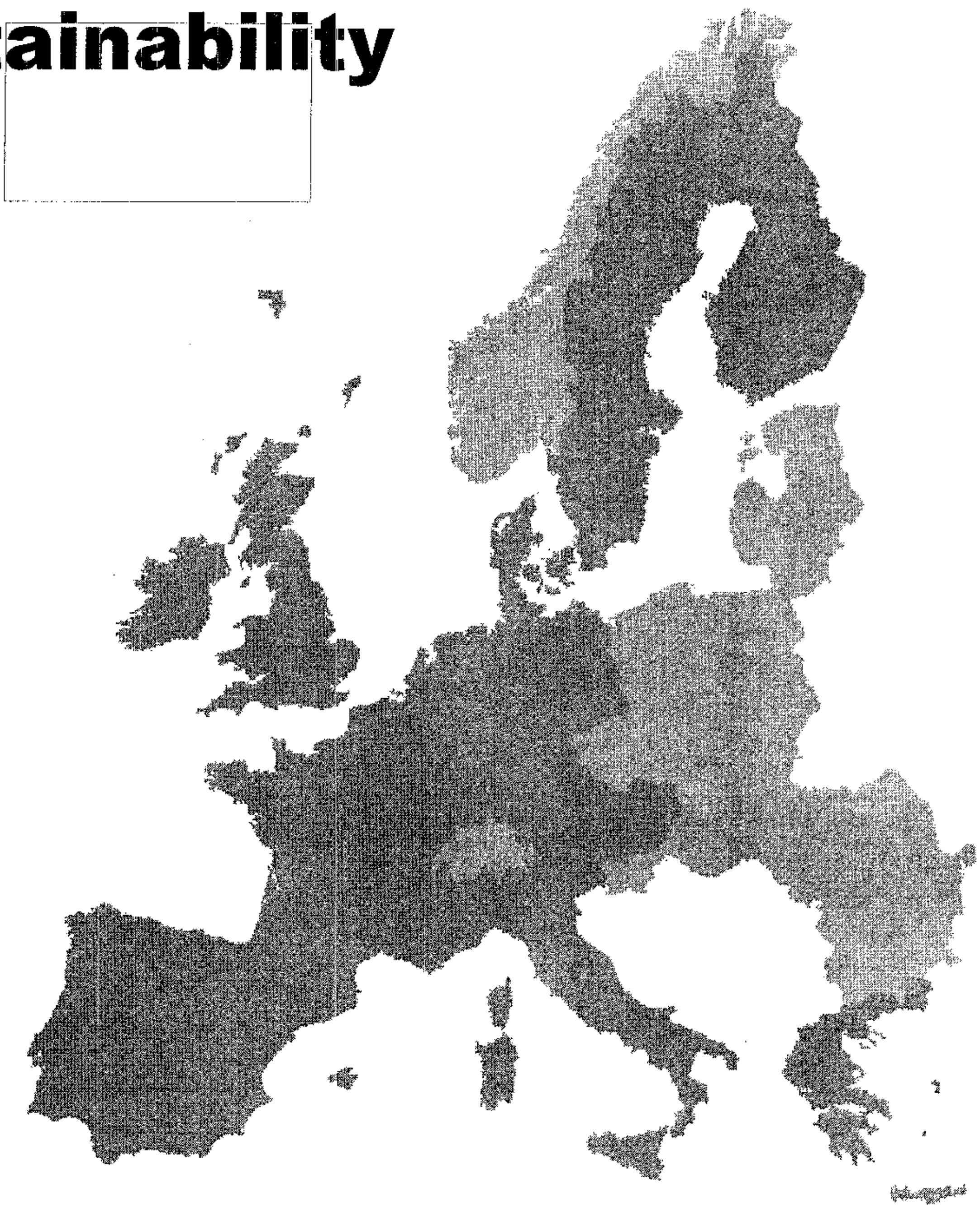
Modelling Sustainability in Europe

Michael Wegener
Institute of Spatial Planning
University of Dortmund

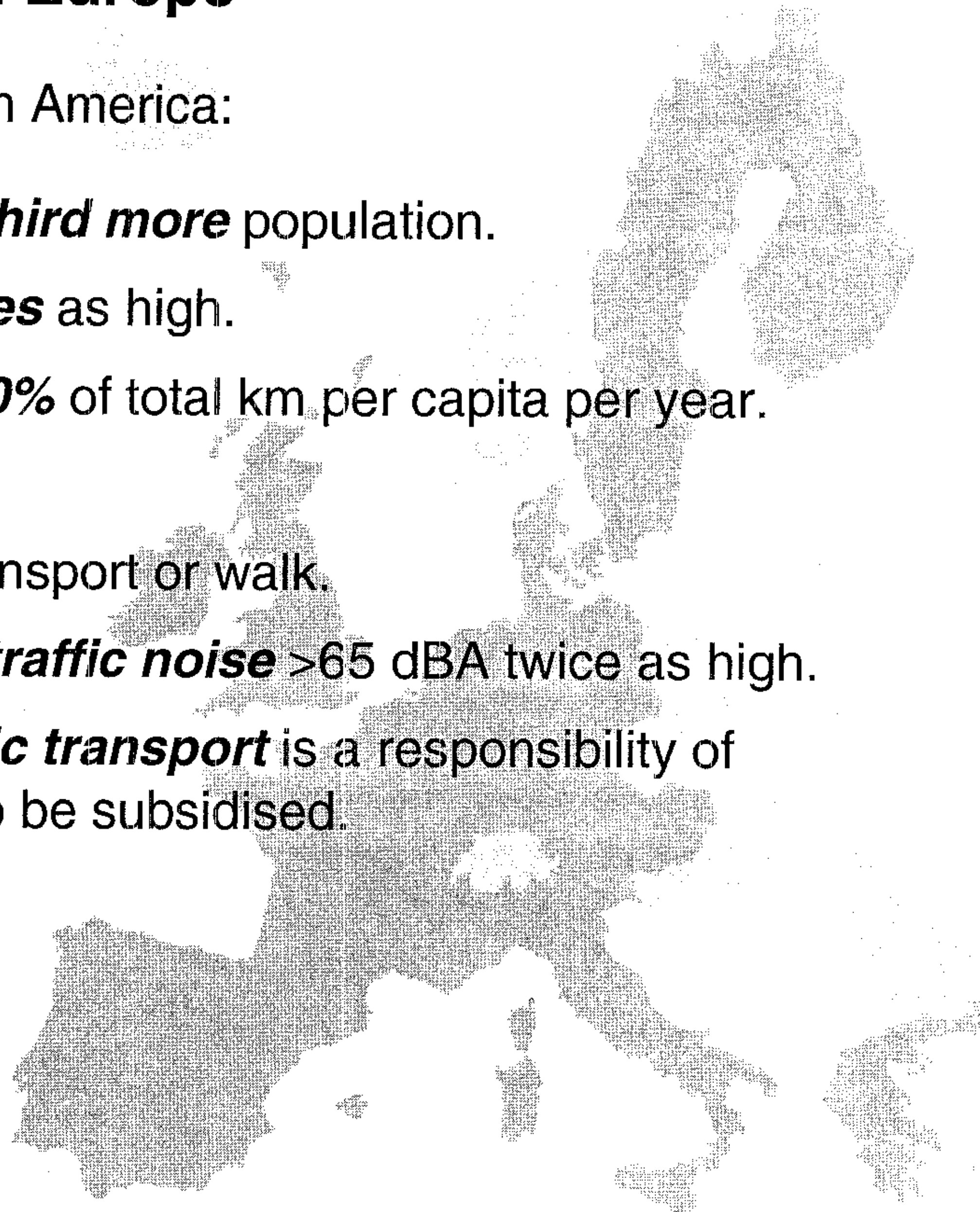


3rd Oregon Symposium
on Integrated Land Use
and Transport Models
Portland, 23-25 July 2002

Sustainability issues in Europe

Europe is ***different*** *from* North America:

- ***One sixth*** of area but ***one third more*** population.
- Population density ***four times*** as high.
- ***30%*** of motorway km and ***40%*** of total km per capita per year.
- ***40%*** less cars per capita
- ***50%*** of urban trips public transport or walk.
- Percent people exposed to ***traffic noise*** >65 dBA twice as high.
- Common tradition that ***public transport*** is a responsibility of government and deserves to be subsidised.



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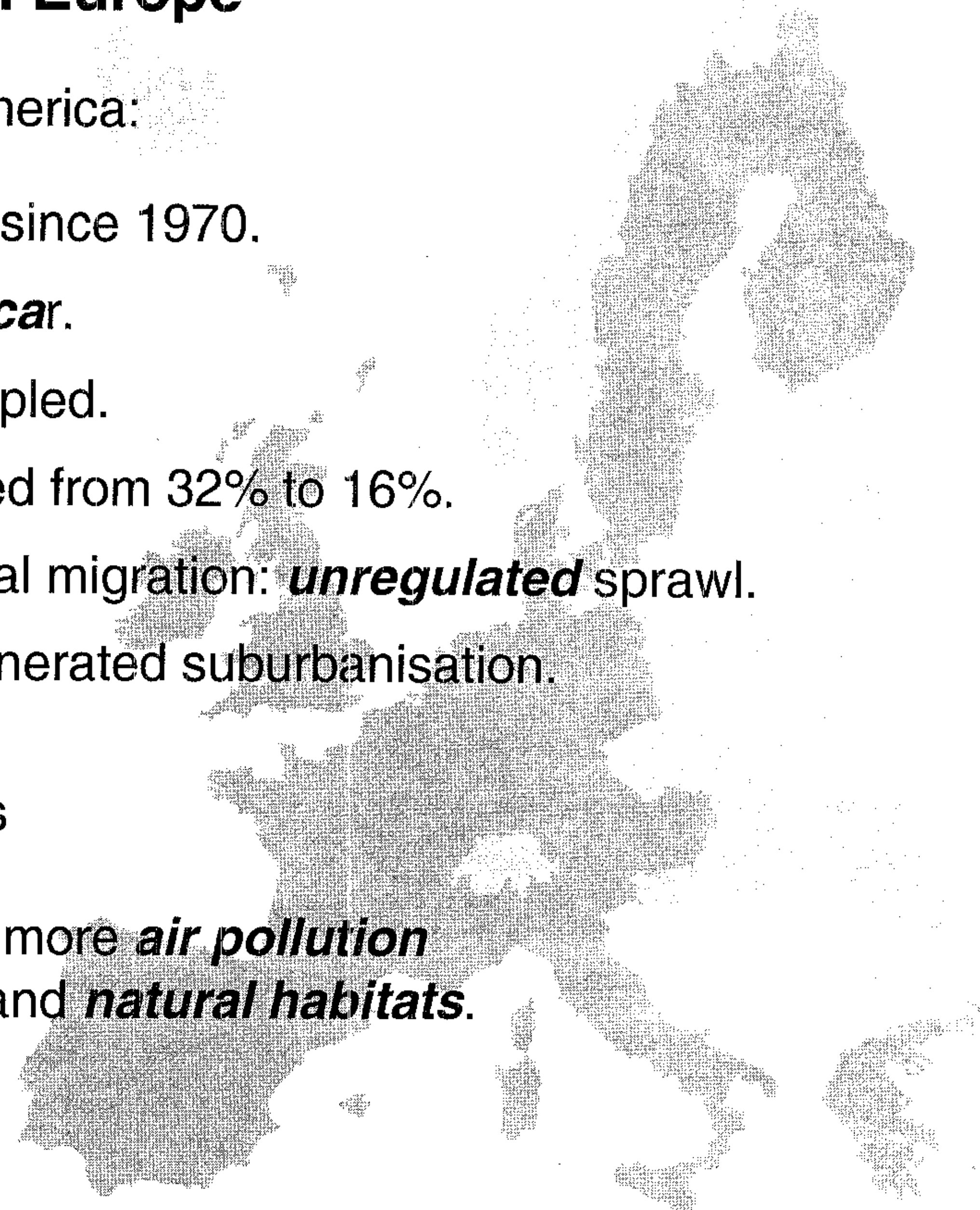
Sustainability issues in Europe

Europe is ***similar*** to North America:

- Pesonbal mobility ***doubled*** since 1970.
- Nearly all extra mobility ***by car***.
- ***Freight*** traffic has almost tripled.
- Freight traffic ***by rail*** declined from 32% to 16%.
- Southern Europe: urban-rural migration: ***unregulated*** sprawl.
- Northern Europe: welath-generated suburbanisation.
- Consequences:
  - ***longer*** trips, more ***car*** trips
  - more ***congestion***
  - more ***greenhouse gases***, more ***air pollution***
  - more loss of ***open space*** and ***natural habitats***.



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This trip pays!

»For these prices and this huge choice I would drive anywhere. The travel costs are easily recovered!«

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Sustainability issues in Europe

Policy responses:

- ***Local*** policies:
  - ***car restraint*** schemes in residential areas (NL)
  - extensive networks of ***cycling lanes*** (NL)
  - ***pedestrianised*** shopping centres (NL)
  - area-wide ***speed limits*** of 30 km/h (D)
  - ***public-transport oriented*** land use planning (NL, GB, DK, S)
  - local government ***land management*** (NL)

- ***Government*** policies:
  - ***fuel price***s four times higher than in the US
  - European ***road pricing*** for lorries planned
  - ***emission control*** legislation lagging behind North America
  - proclaimed ***emission reduction goals*** not achieved

Sustainability issues in Europe

European ***policy documents*** (selection):

- *'Green Book'* Sustainable Urban Development (1998):
  "... to protect and improve the urban environment: towards local and global sustainability" by *"more environmental sustainable cities: avoid imposing costs of development to their immediate environment, surrounding rural areas, regions, the planet itself and future generations".*

- Protocol to the UN Climate Change Convention (1997):
  ... *reduce emission of CO_2, CH_4, N_2O, HFCs, PFCs and SF_6 by 8% of 1990 levels by 2012.*

- Developing the citizens' network (1998):
  "... support the role of local and regional passenger transport in contributing to economic development and employment, reducing congestion, using less energy, producing fewer pollutants, making less noise, reducing social exclusion and improving quality of life".

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Sustainability issues in Europe

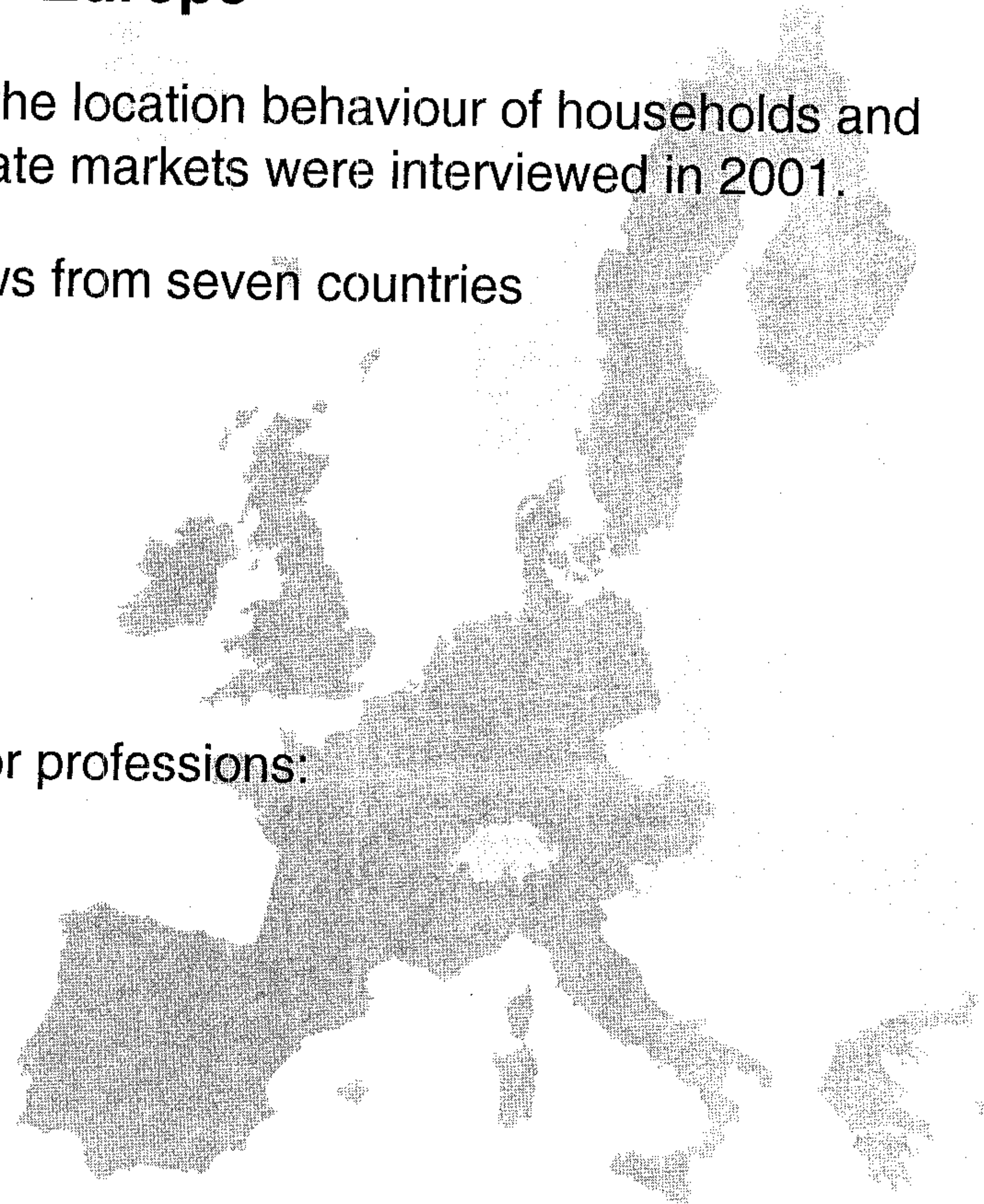
Twenty experts familiar with the location behaviour of households and firms and with urban real-estate markets were interviewed in 2001.

The experts represented views from seven countries

- Belgium (2)
- Finland (4)
- Germany (3)
- Italy (5)
- Spain (4)
- United Kingdom (2)

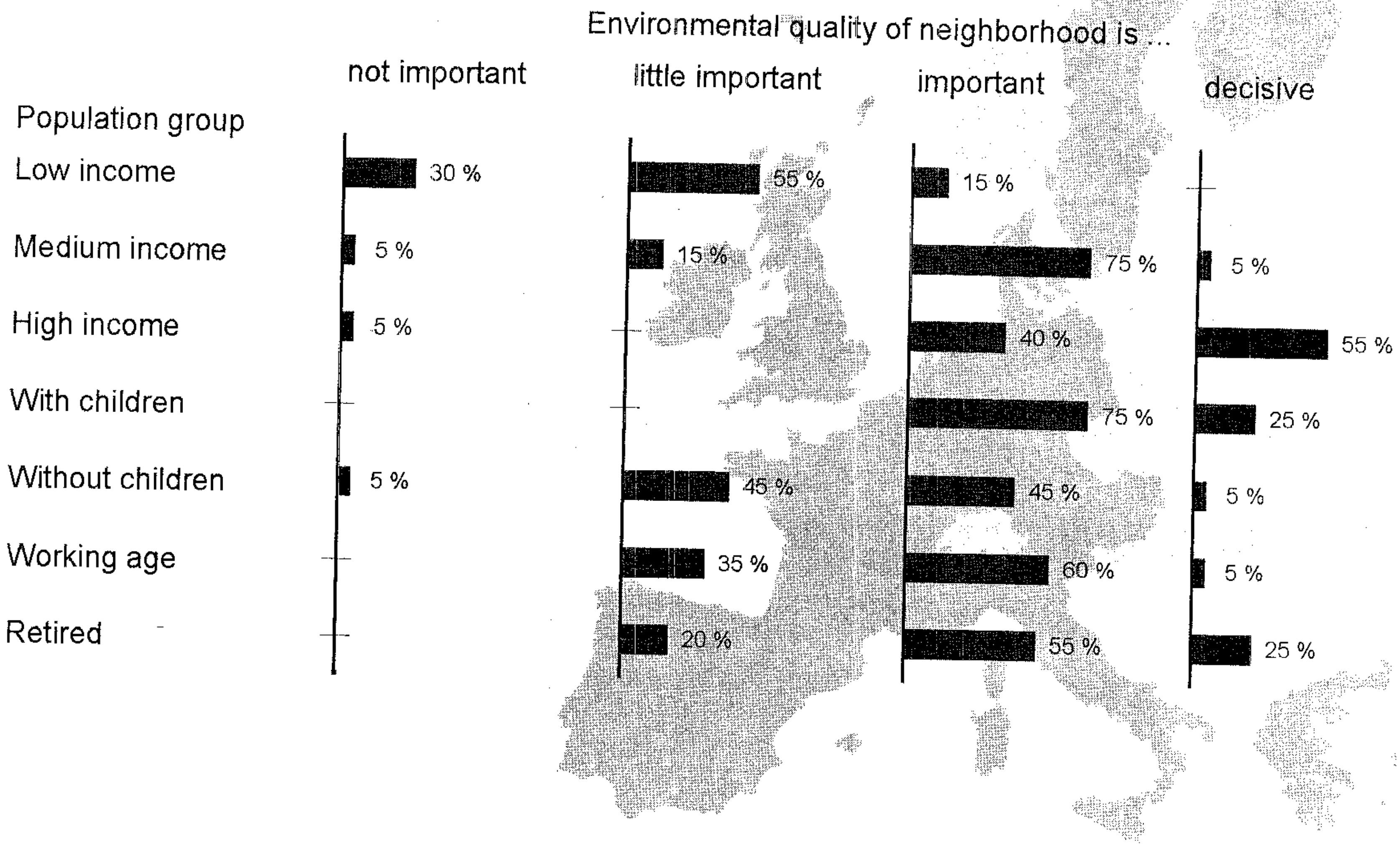
and from the following fields or professions:

- public administration (7)
- real estate (4)
- consulting (5)
- university (5)



Sustainability issues in Europe

Environmental quality of the neighbourhood is ***important*** or ***decisive*** for the location choice of households.



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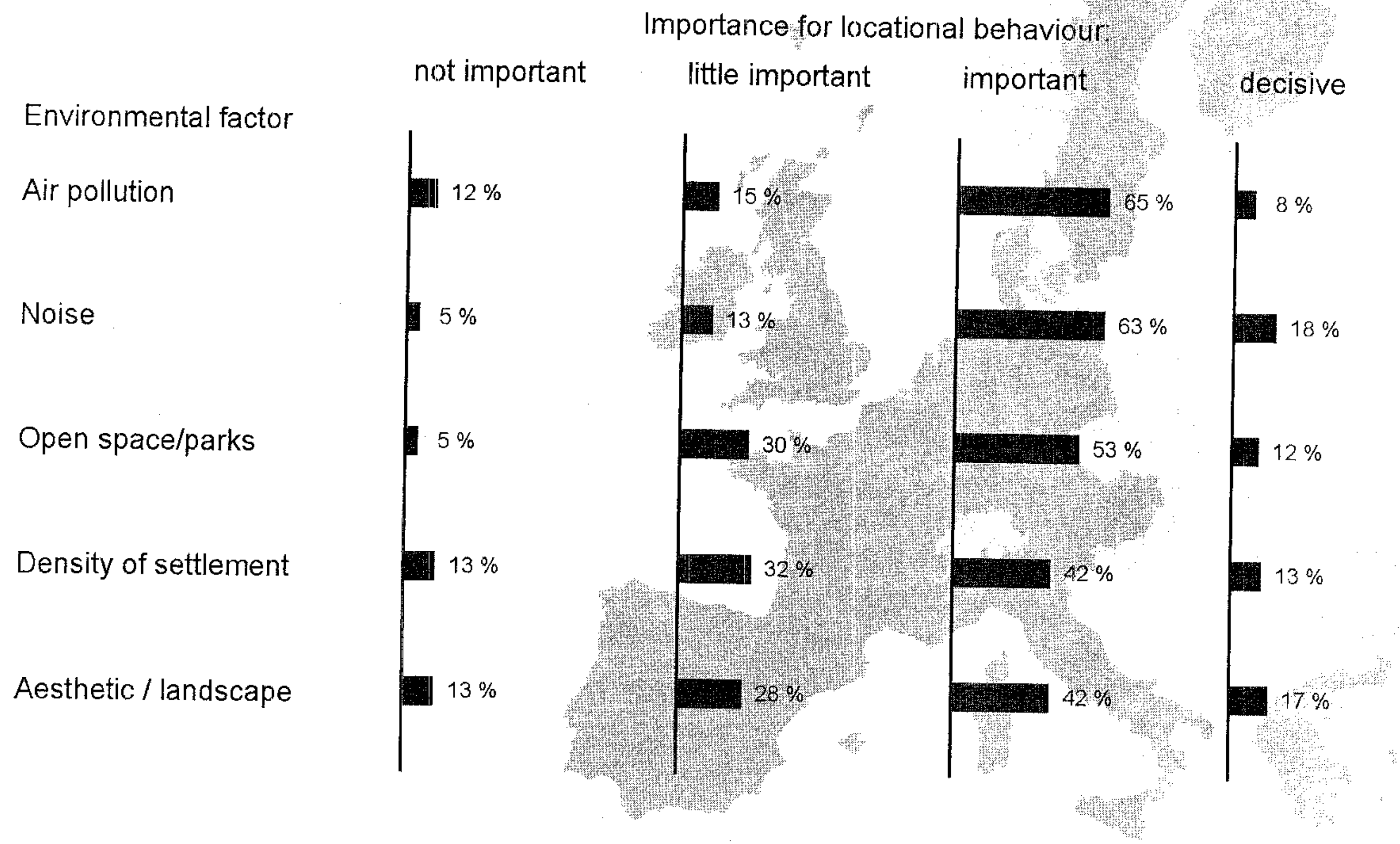
Sustainability issues in Europe

Clean air, ***absence of noise*** and ***good access to open space*** are the most important environmental factors for households.



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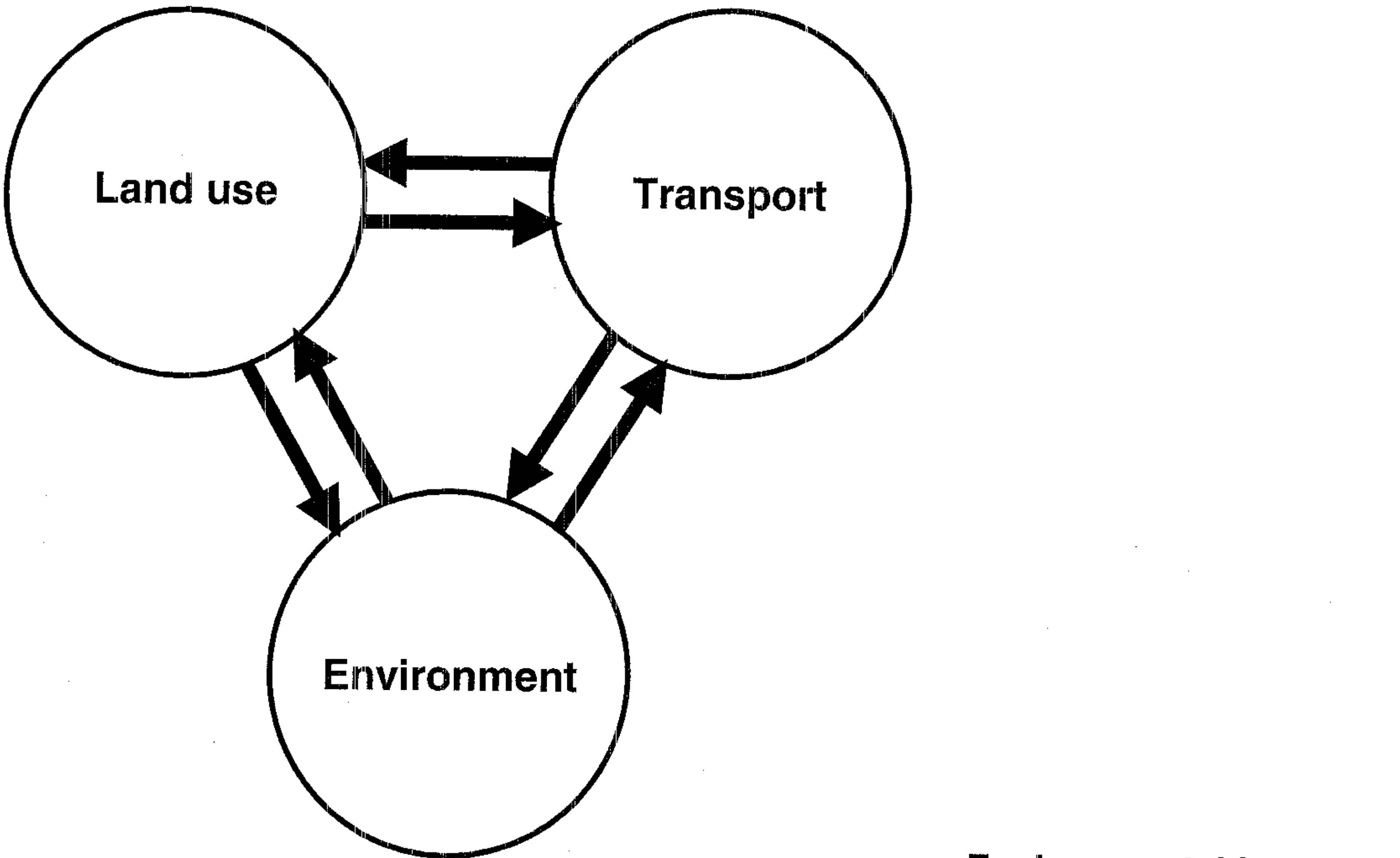
Modelling sustainability



Modelling sustainability

Evironmental impacts

- ○ weak impact
- ● strong impact

Evironmental feedback

- ○ weak impact
- ⬤ strong impact

Cause \ Effect		Land use	Transport	Resources: Energy	Water	Land	Vegetation	Wildlife	Microclimate	Emissions: Greenhouse gases	Air pollution	Water pollution	Soil contamination	Solid waste	Noise	Immissions: Air quality	Surface water flows	Ground water flows	Noise propagation
	Land use	●	●	●	●	●	●	●	●	●	●	○	●	●	●	●	●	●	●
	Transport	●	●	●		●	○	○		●	●	○	○	○	●	●			●
Resources	Energy	○	○	●						●	●					●			
	Water				●												●	●	
	Land (open space)	⬤			●	●	●	●	●								●	●	○
	Vegetation	○			○		●	●	●	●									●
	Wildlife							●											
	Microclimate	○					○	○	●										
Emissions	Greenhouse gases									●									
	Air pollution								●		●					●			
	Water pollution				●		●	●				●					●	●	
	Soil contamination	○				●	●	●				●	●						
	Solid waste	○			○	○							●	●			●	●	
	Noise														●				●
Immissions	**Air quality**	⬤					●	○	●			○	○			●			
	Surface water flows				●		●	●	●								●		●
	Ground water flows				●		●	●	●									●	
	Noise propagation	⬤						●											●

CQ535

Modelling sustainability

Environmental models (examples):

Air distribution models

- model the two- or threedimensional distribution of pollutants from emission sources with or without photochemical reaction.
- require raster data of emission sources and topographical features such as elevation and surface characteristics such as green space, built-up area and high-rise buildings.

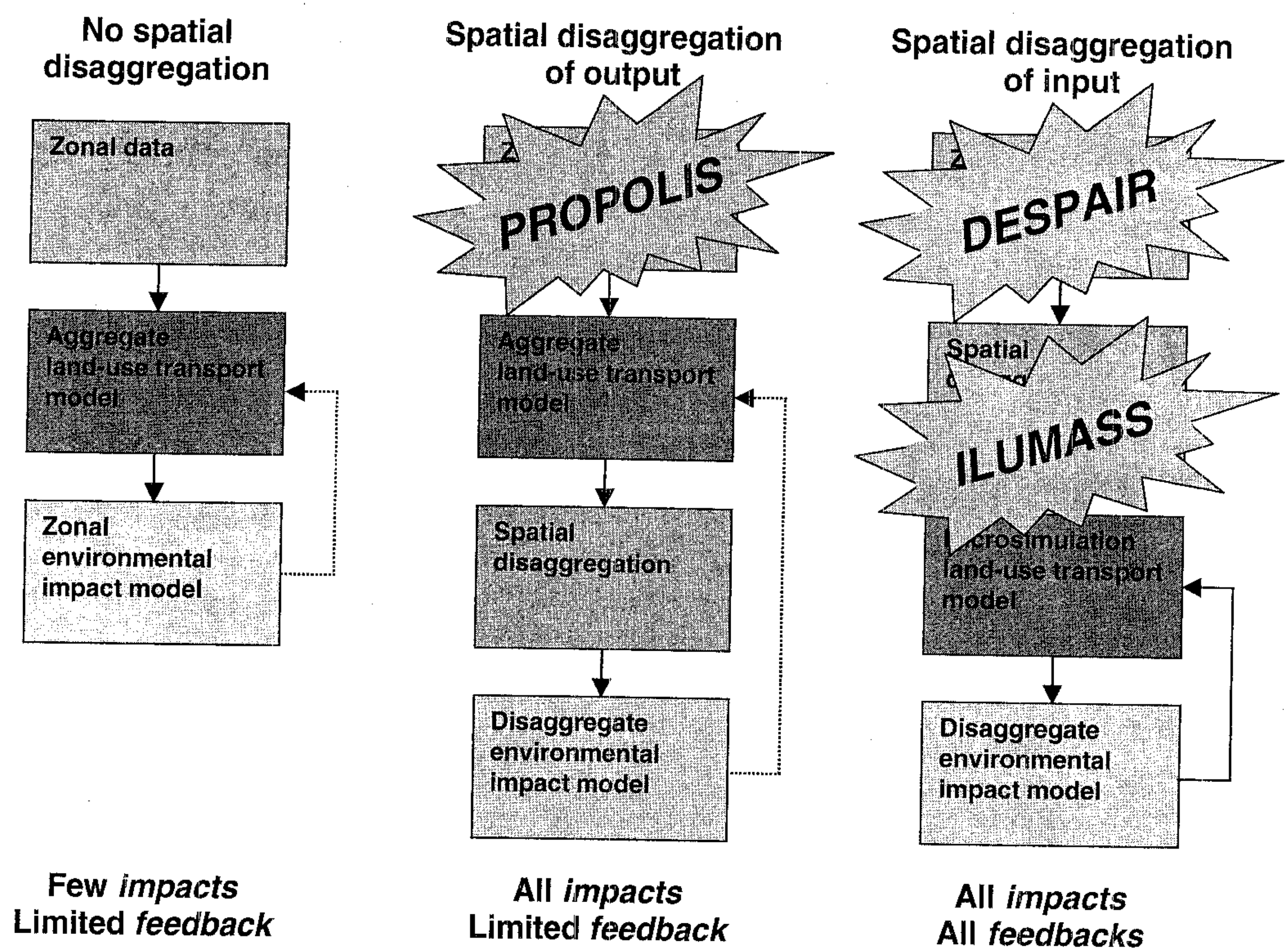
Noise propagation models

- model the propagation of noise from emission sources with or without single or multiple reflection.
- require spatially disaggregate data on emission sources, topography, land cover and sound barriers such as dams, walls or buildings.

Existing land-use transport models lack the ***spatial resolution*** required by environmental models.

CQ535

Modelling sustainability



CQ535

PROPOLIS

Planning and Research of Policies for Land Use and Transport for Increasing Urban Sustainability

Objectives

- to research, develop and test ***integrated land use and transport policy assessment tools*** and methodologies to define ***sustainable urban strategies*** and to demonstrate their long-term effects,

Partners

- ***LT Consultants Ltd.***, Helsinki (Coordinator)
- ***Institute of Spatial Planning***, University of Dortmund
- ***Spiekermann and Wegener (S&W)***, Dortmund
- ***University College London***, London
- ***Marcial Echenique & Partners Ltd.***, Cambridge
- ***Trasporti e Territorio srl***, Milan
- ***Marcial Echenique y Compañia SA***, Bilbao
- ***STRATEC S.A.***, Brussels.

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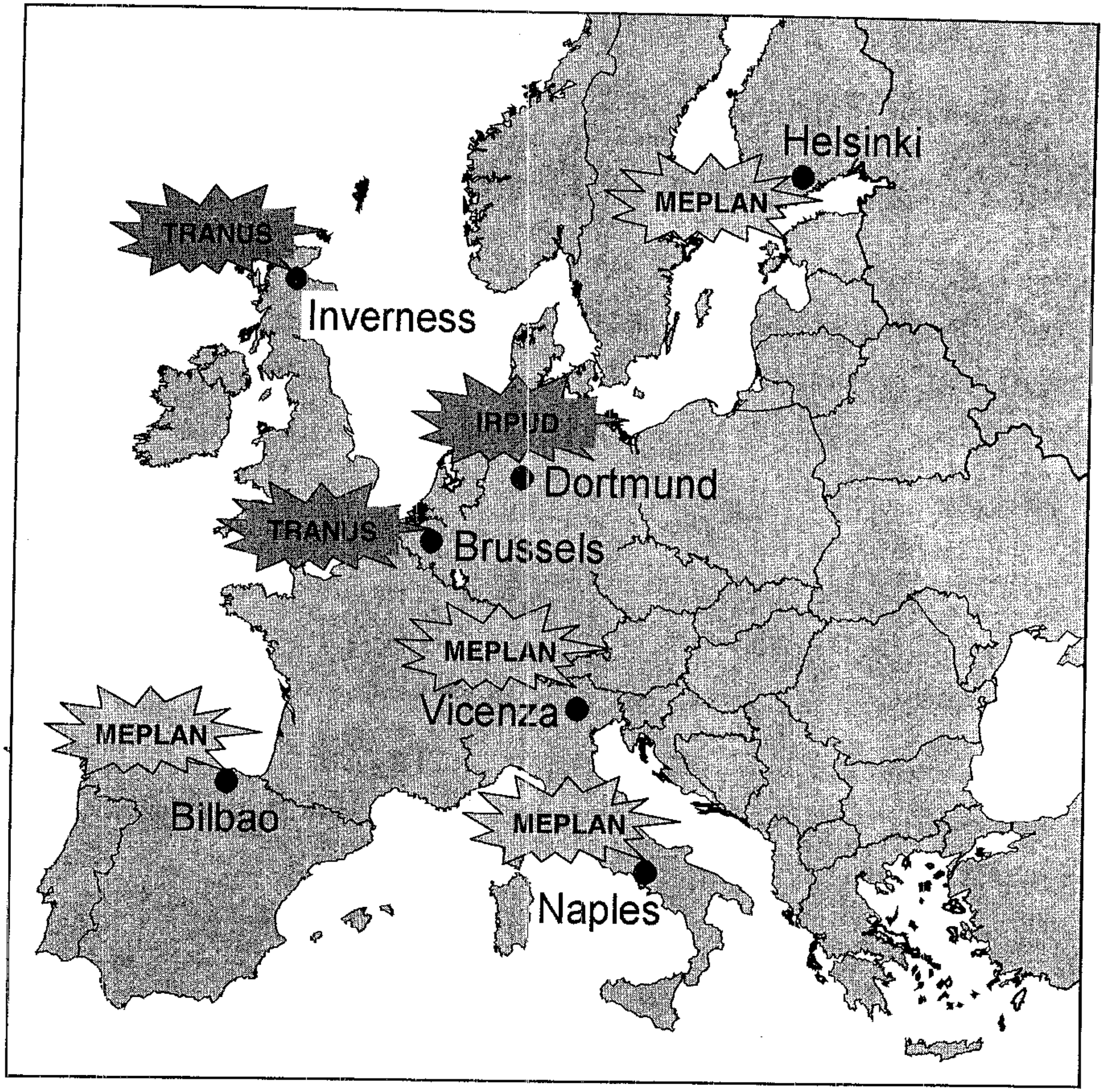
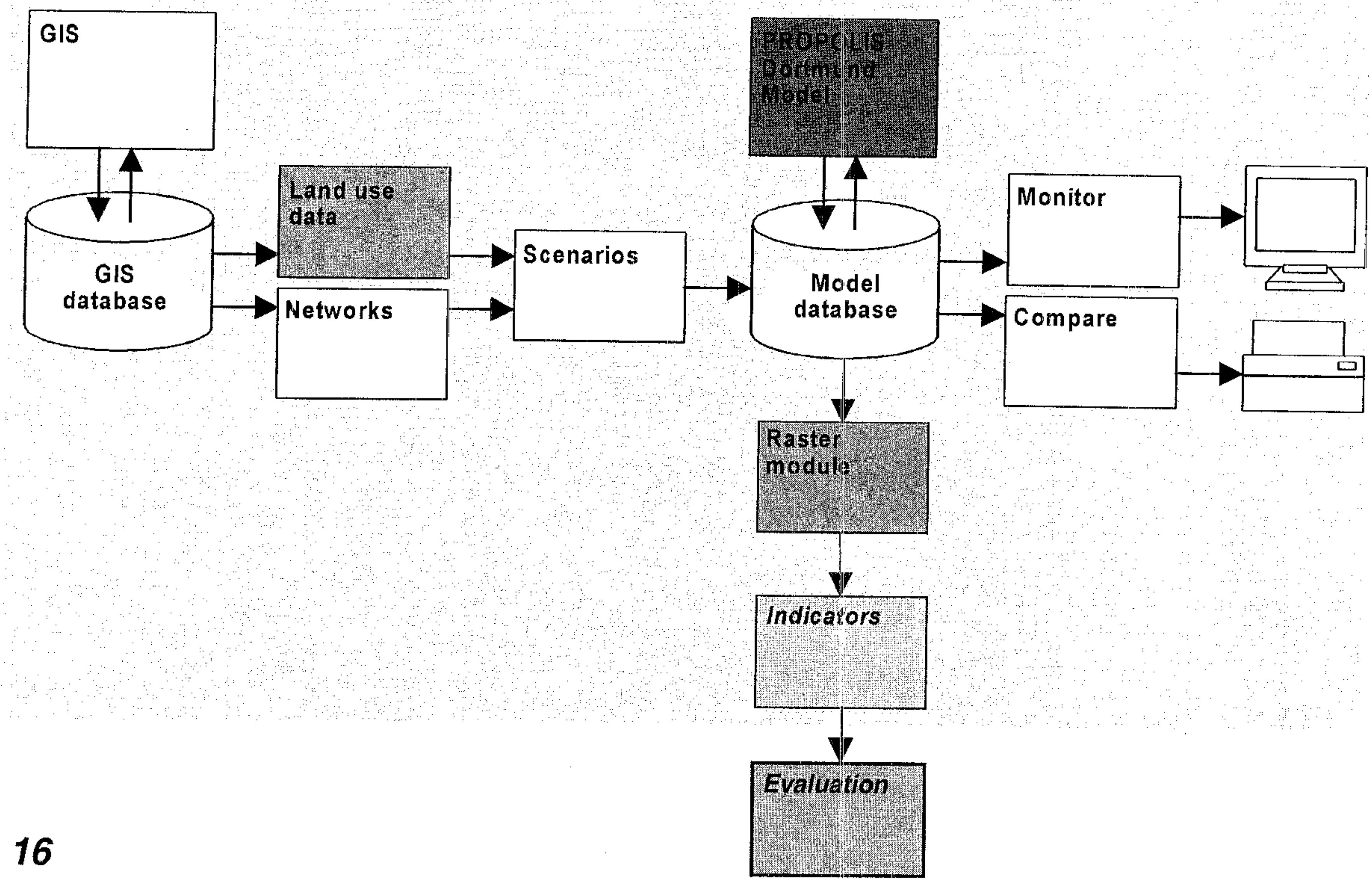
PROPOLIS

Case study
cities/models



CQ535

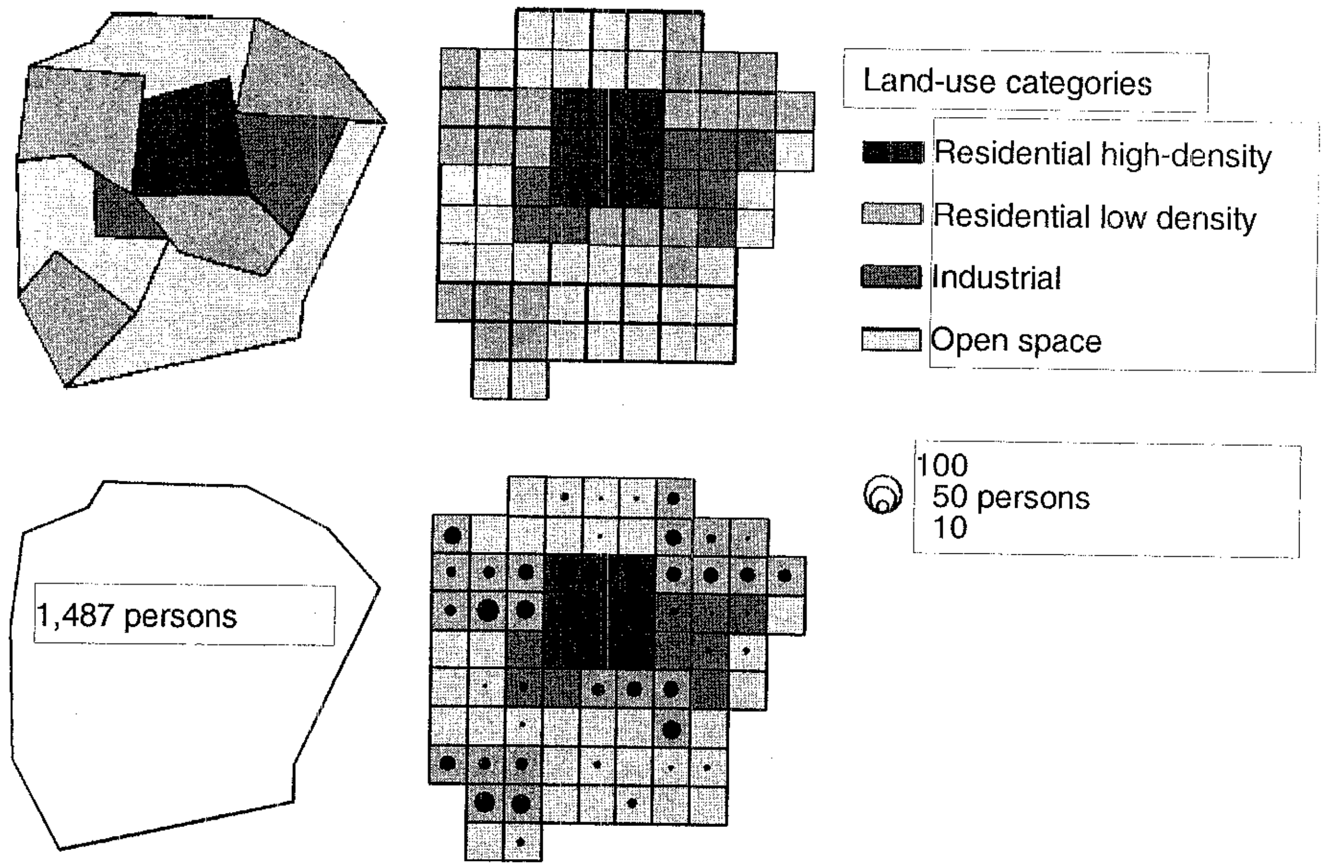
PROPOLIS Dortmund Model



CQ535

PROPOLIS Dortmund Model

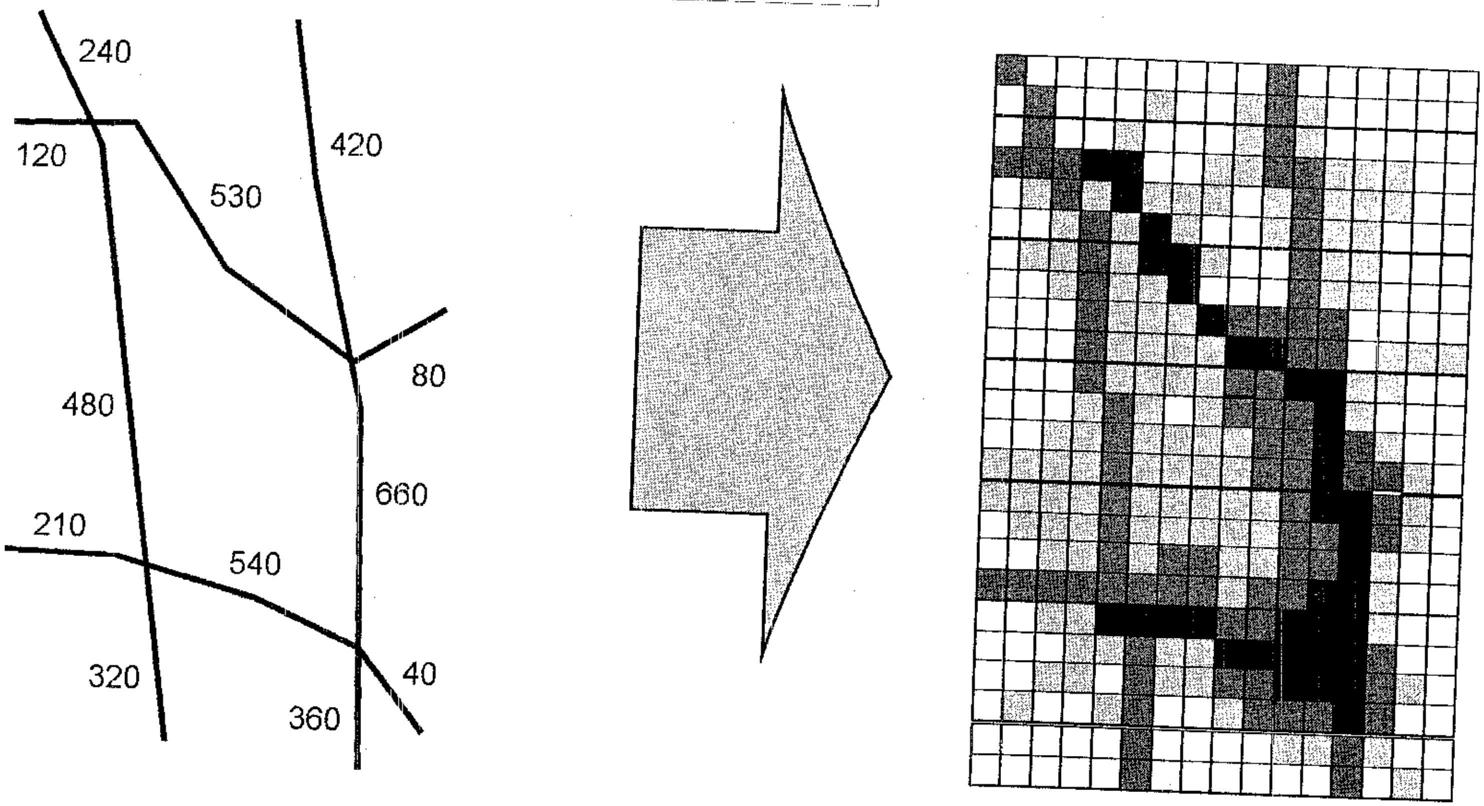
Conversion of zonal data to raster data



CQ535

PROPOLIS Dortmund Model

Conversion of network data to raster data



plus car traffic on functional links:
670 car access trips from zone to network
410 car trips from network to zone parking
340 intrazonal car trips

no car traffic
1 - 100 cars
101 - 500 cars
501 - ... cars

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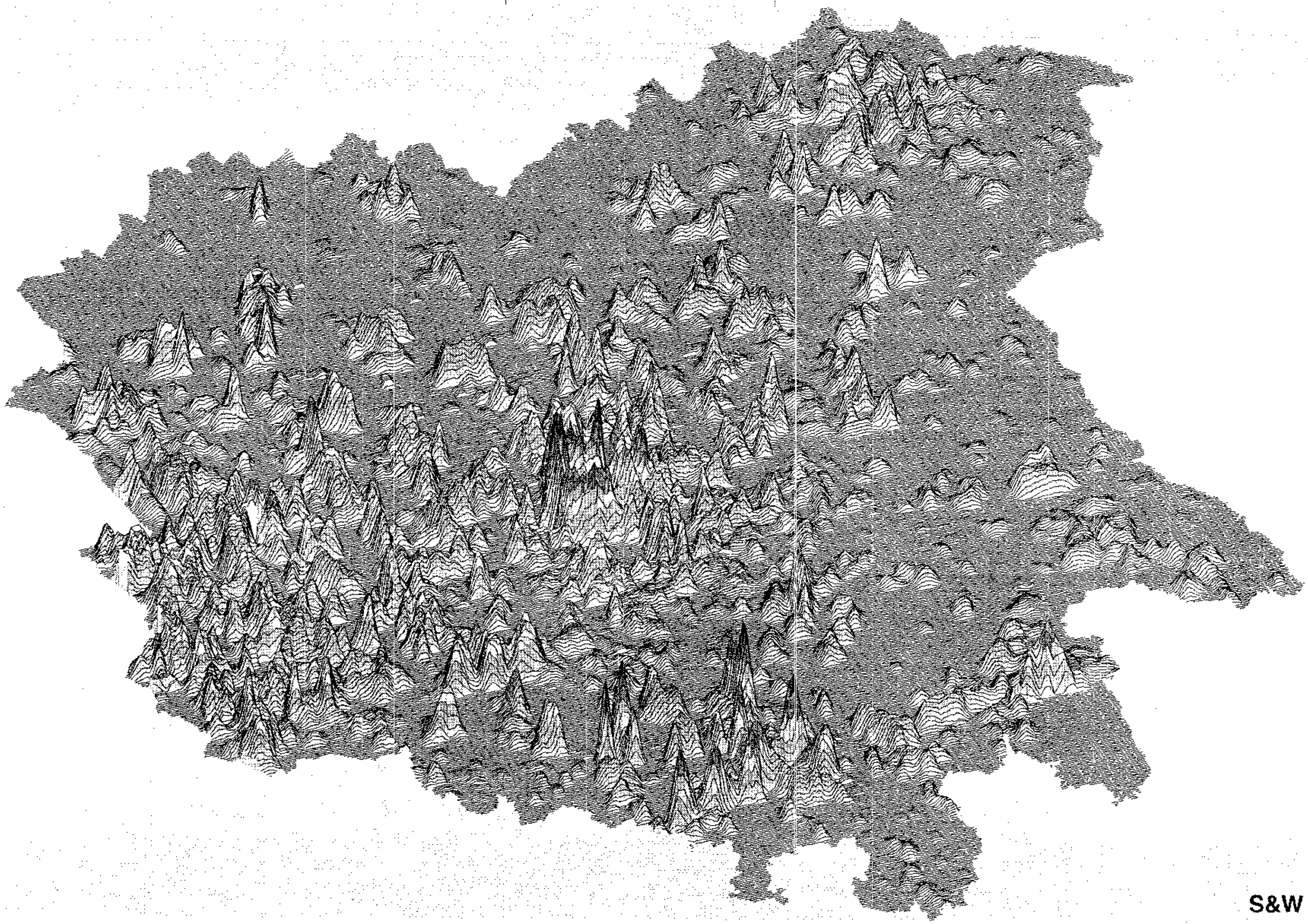
PROPOLIS

Sustainability indiactors

Environmenl	***Climate change***	Greenhouse gases from transport
	Air pollution	**Acidifying gases from transport**
		Volatile organic compounds from transport
	Natural resources	Consumption of mineral oil products
		Land coverage
		Need for additional new construction
	Environmental quality	**Fragmentation of open space**
		Quality of open space
Social	***Health***	Exposure to PM from transport at housing
		Exposure to NO_2 at housing
		Exposure to traffic noise
		Traffic fatalities
		Traffic injuries
	Equity	Justice of distribution of economic benefits
		Justice of exposure to PM
		Justice of exposure to NO_2
		Justice of exposure to noise
		Segregation
	Opportunities	Housing standard
		Vitality of city centre
		Vitality of surrounding region
		Productivity gain from land use
	Accessibility and traffic	Total time spent in traffic
		LOS of public transport and slow modes
		Accessibility to city centre
		Accessibility to services
		Accessibility to open space
Economic	***Benefit***	Economic benefit

CQ535

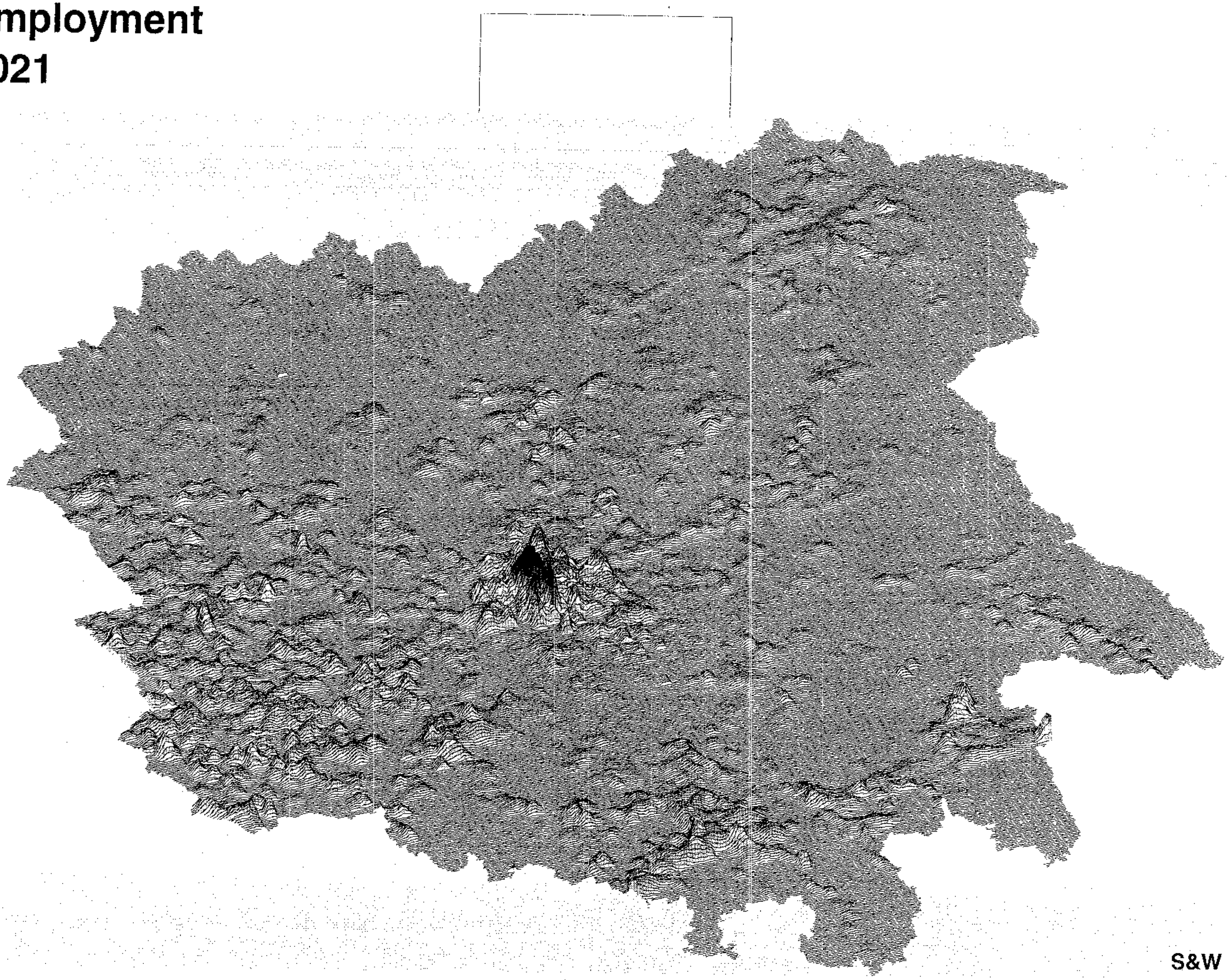
Population
2021



S&W

CQ535

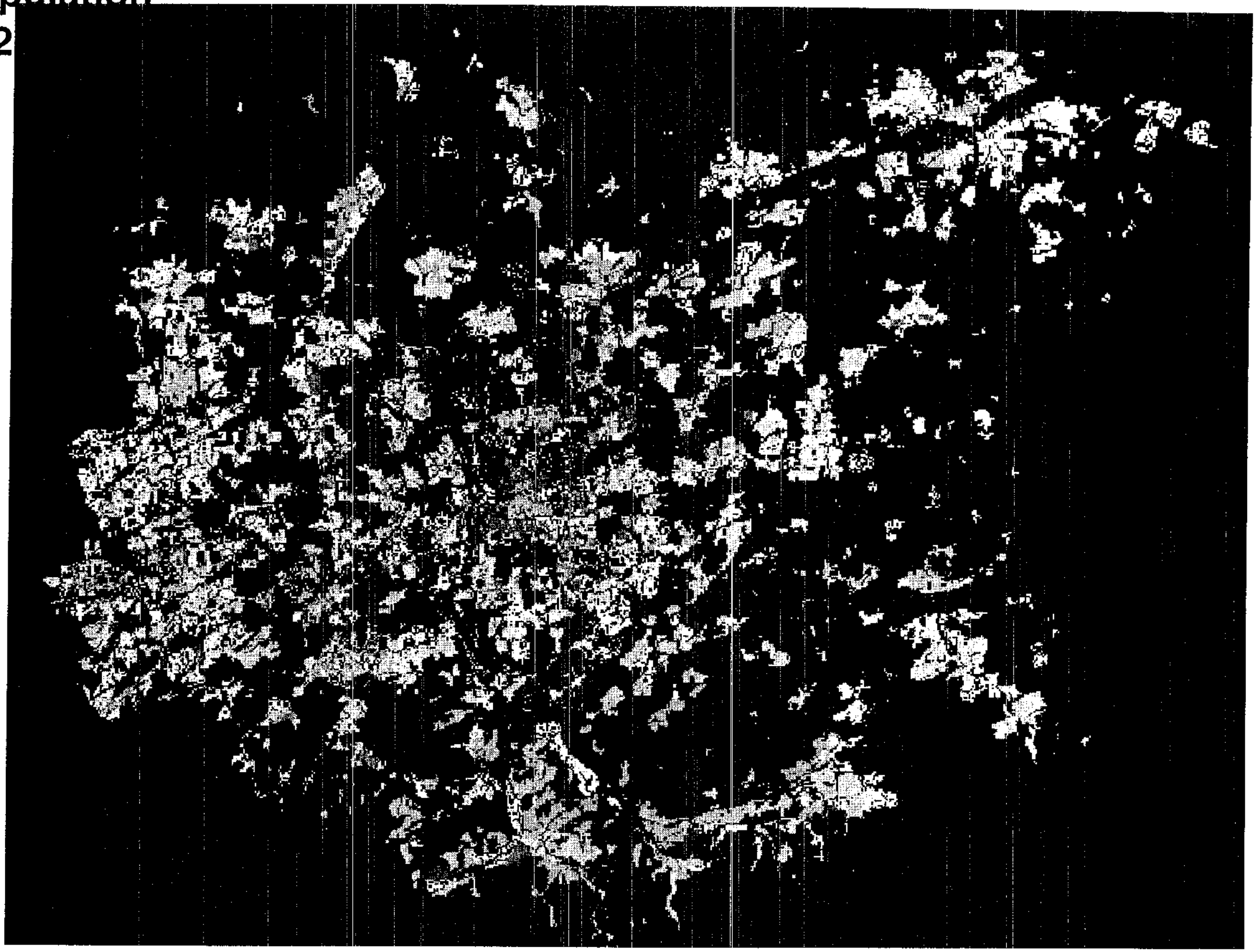
Employment
2021



S&W

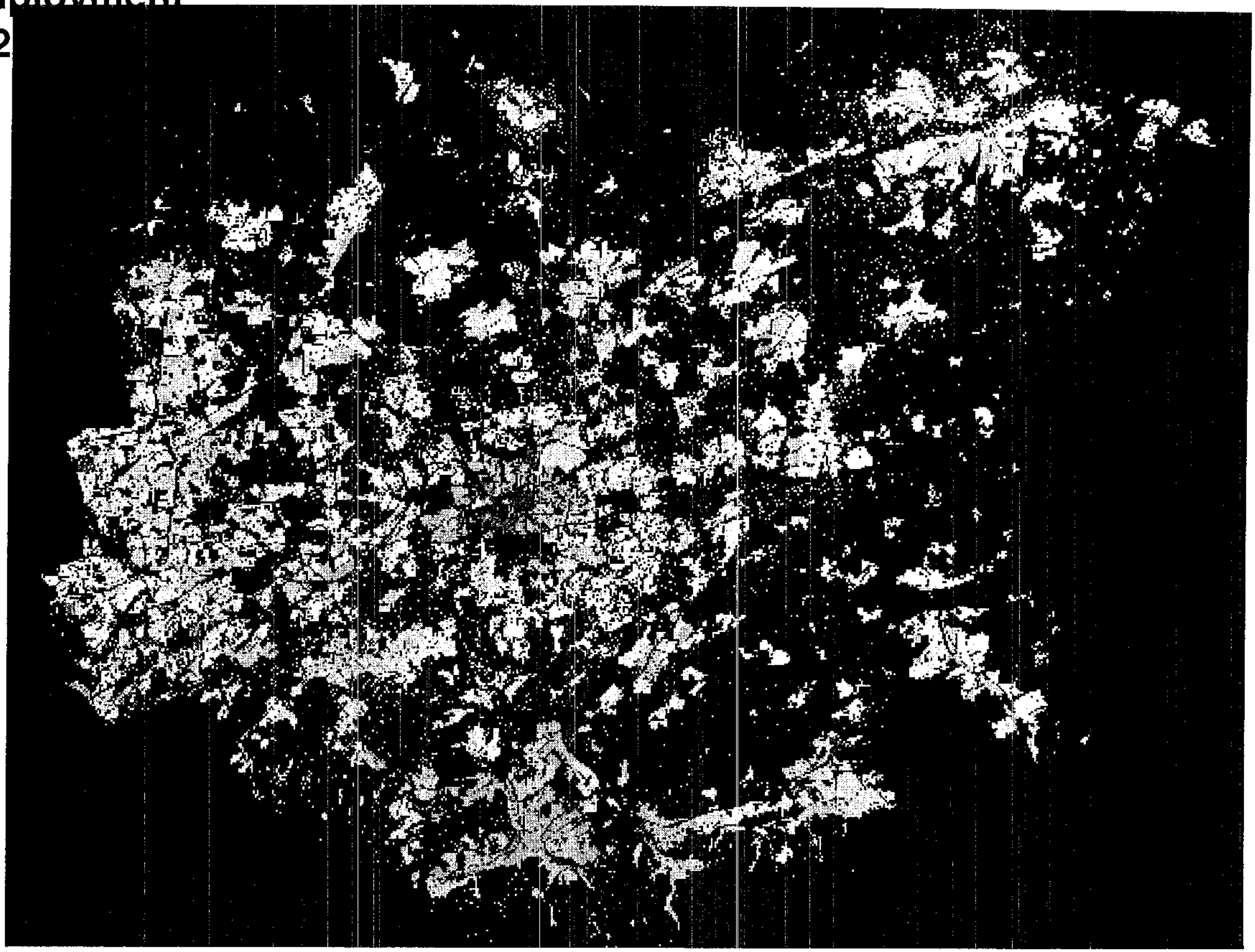
CQ535

Population
202



CQ535

Employment 202

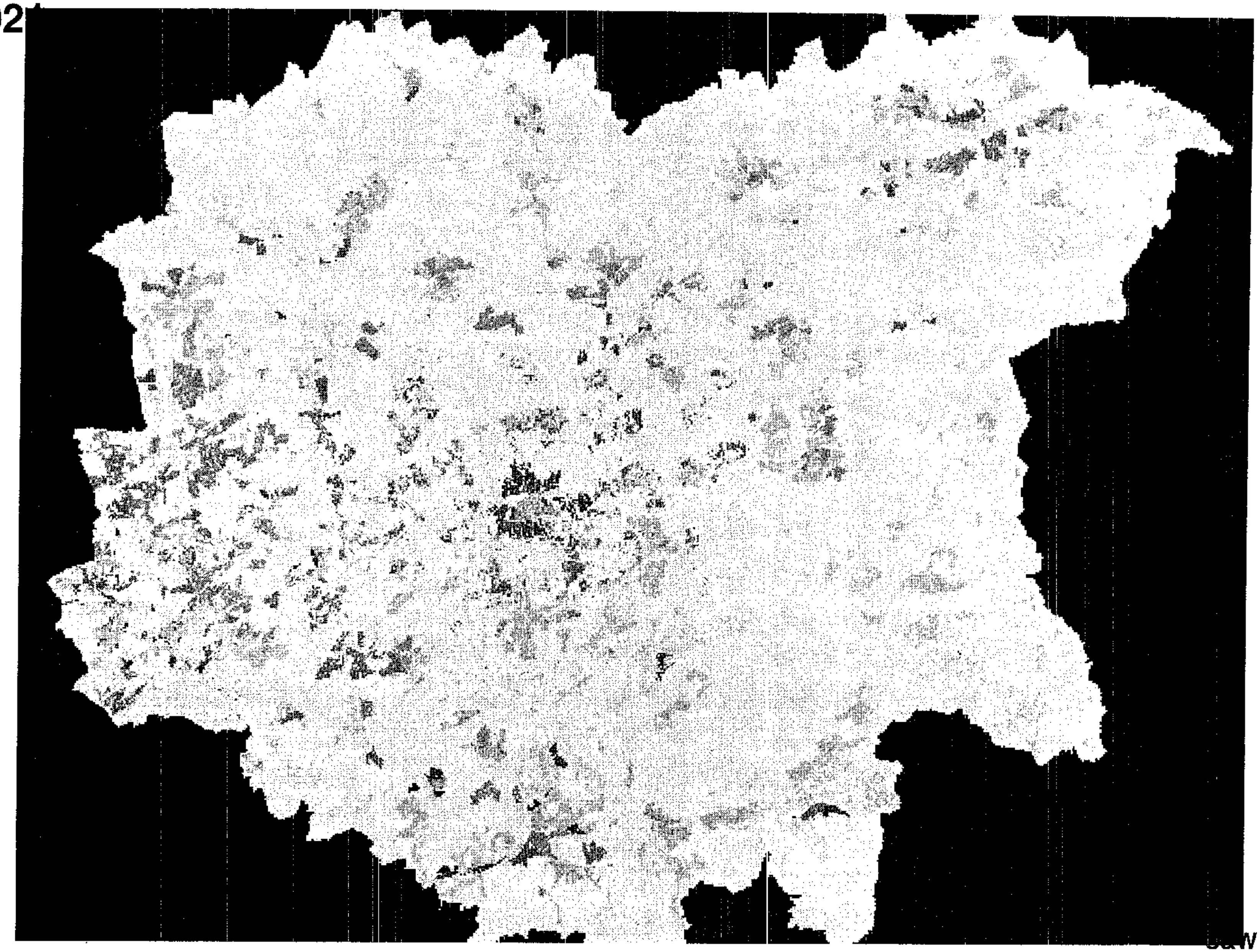


CQ535

Land use
202

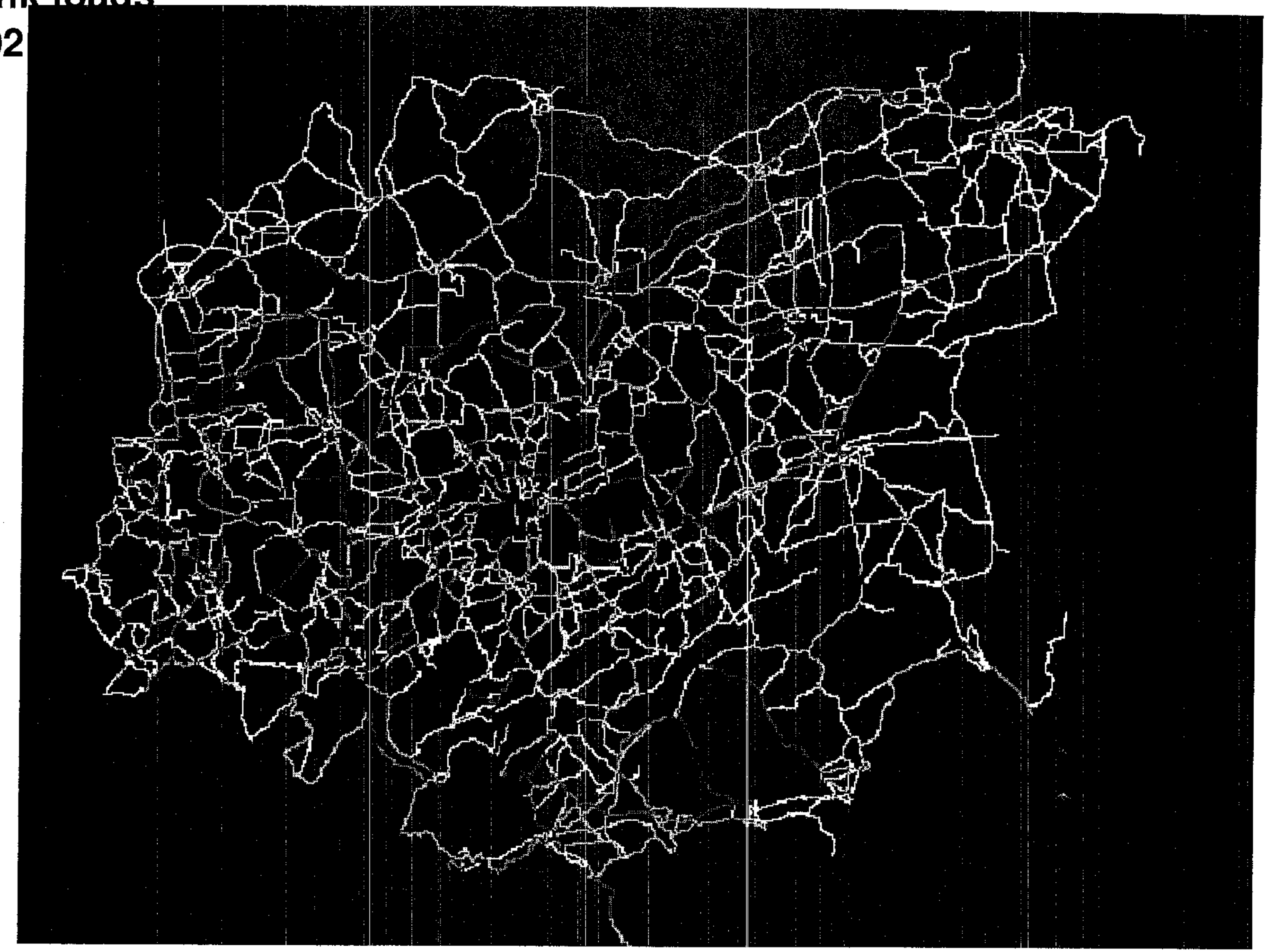
CQ535

Land coverage
202



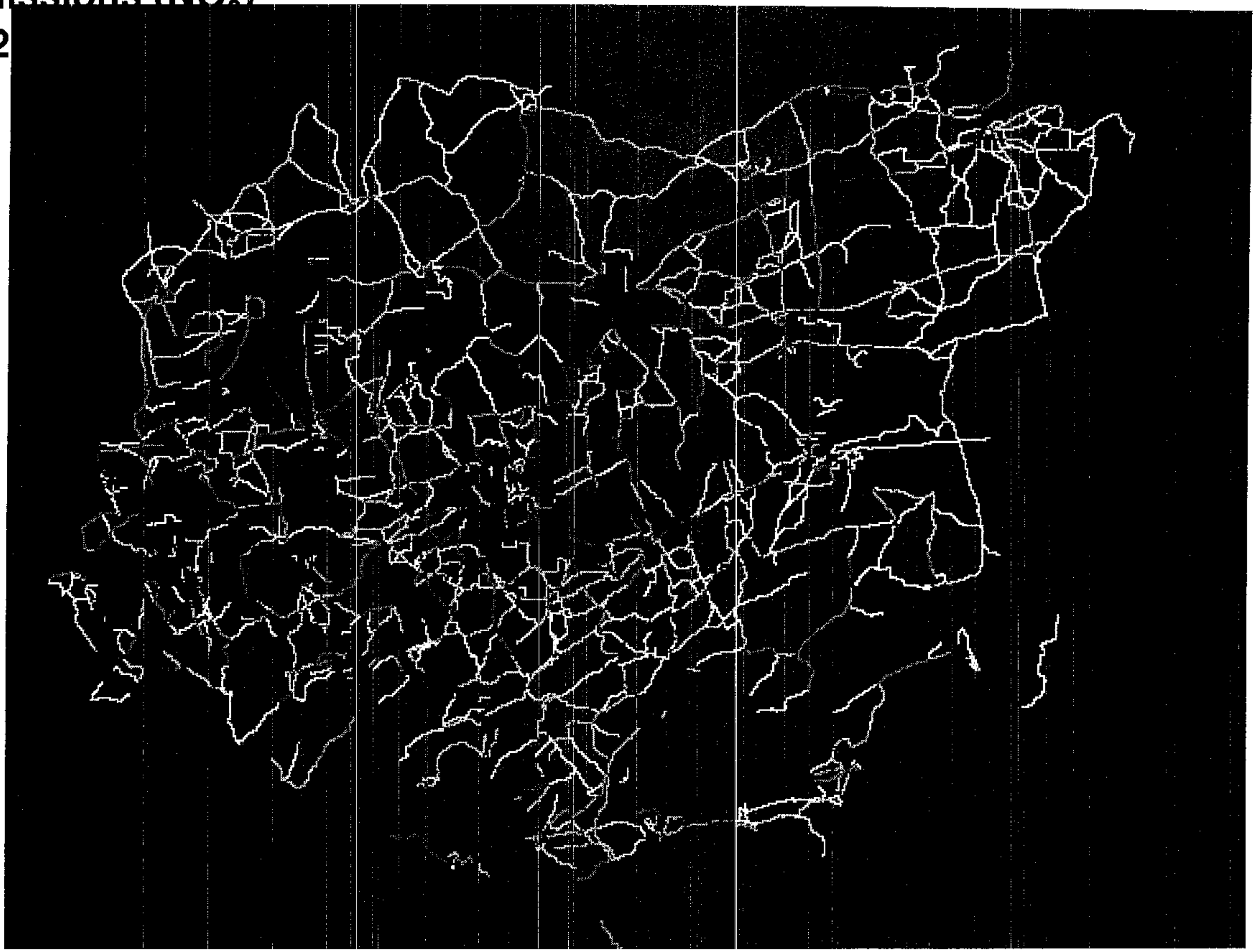
CQ535

Link loads
202



CQ535

Emissions (NO_x)
202



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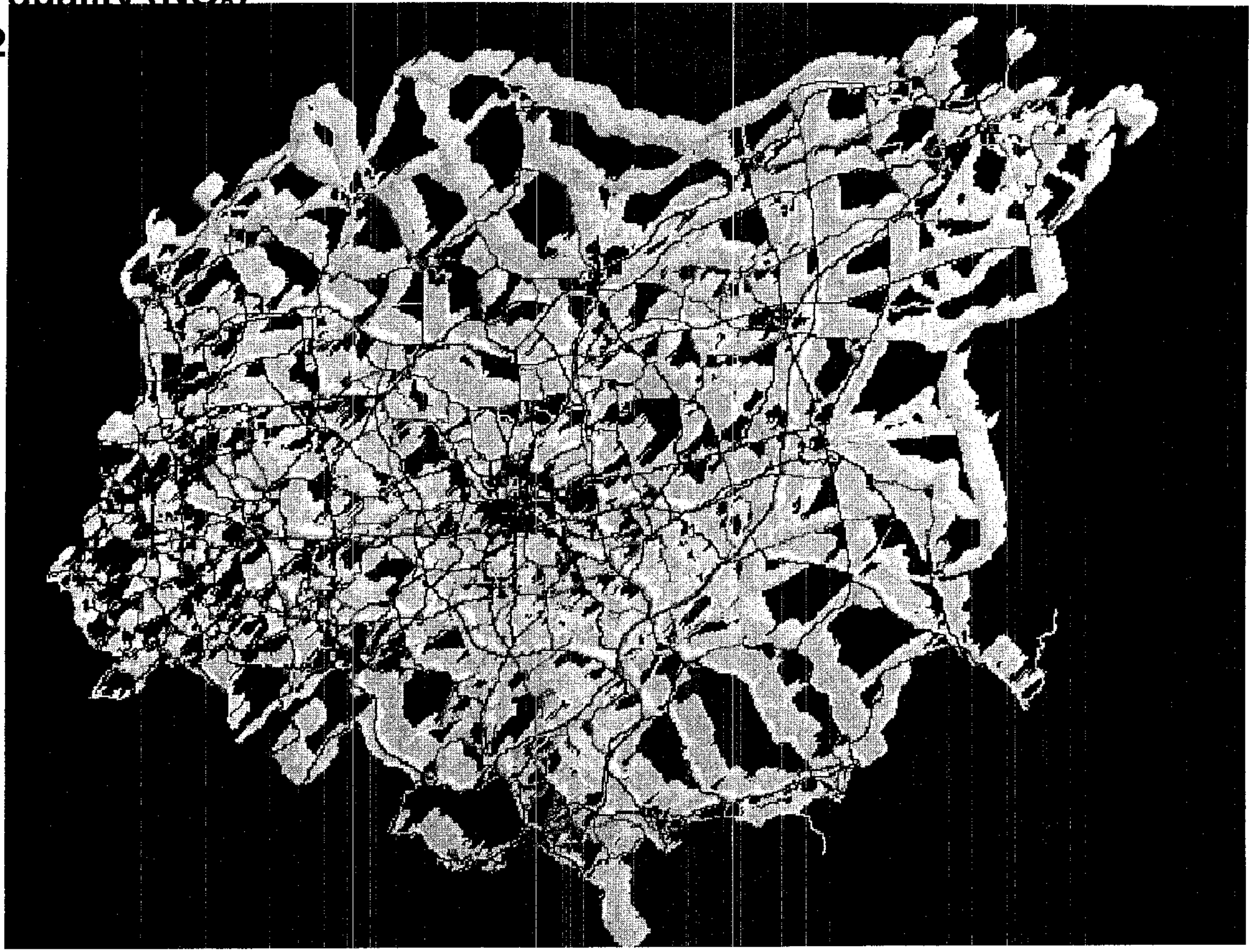
Air quality (NO_2)
202



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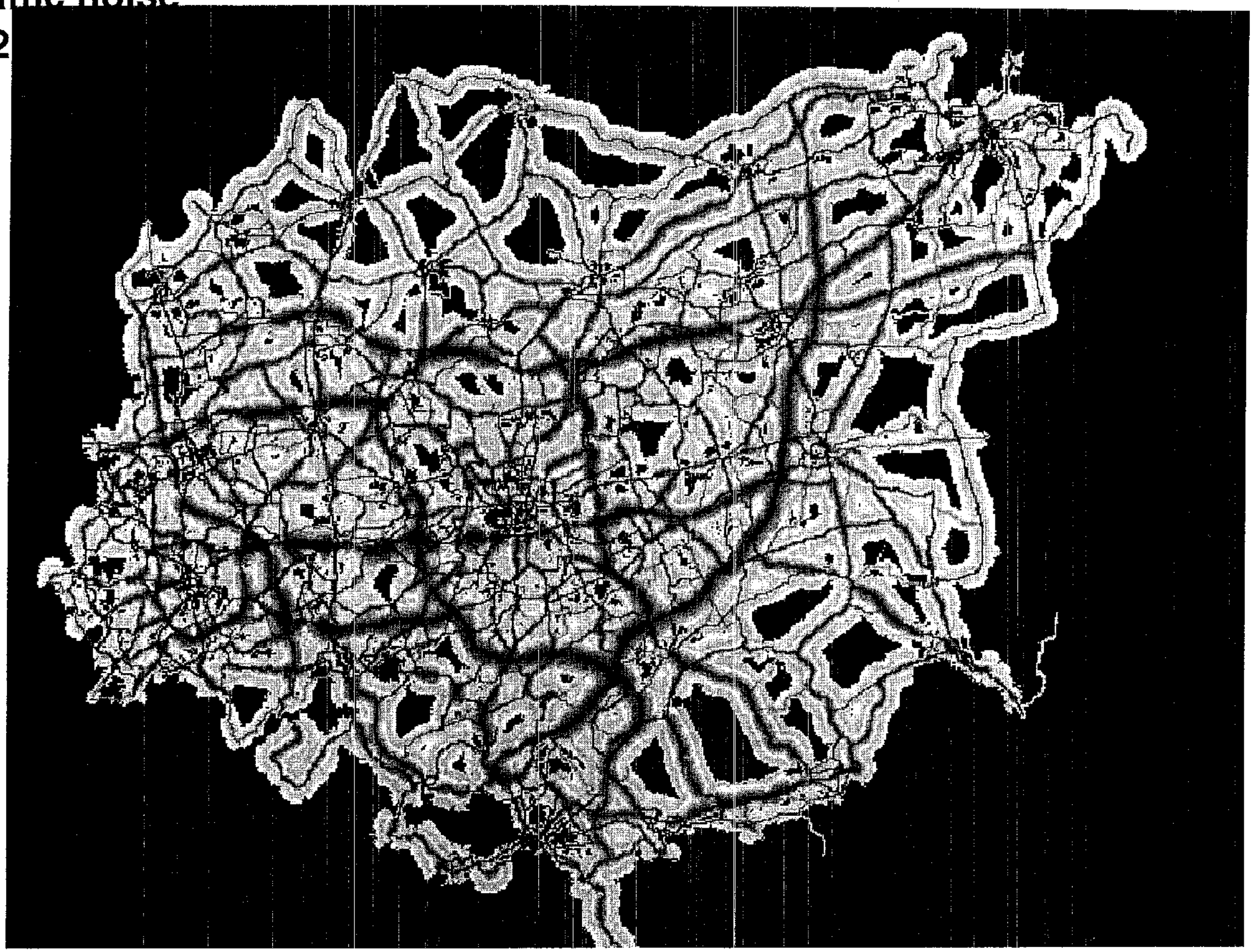
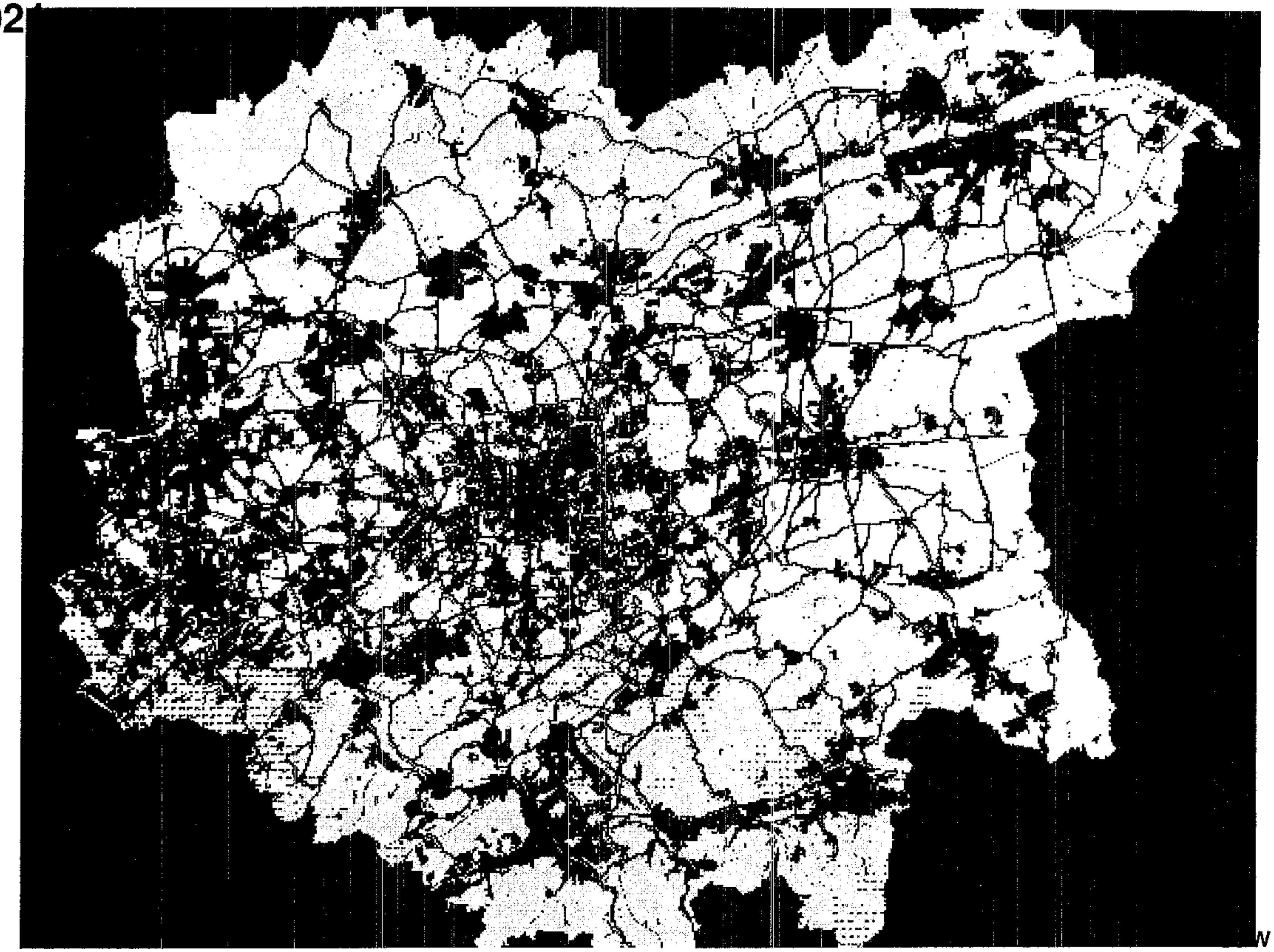
Traffic noise
202



CQ535

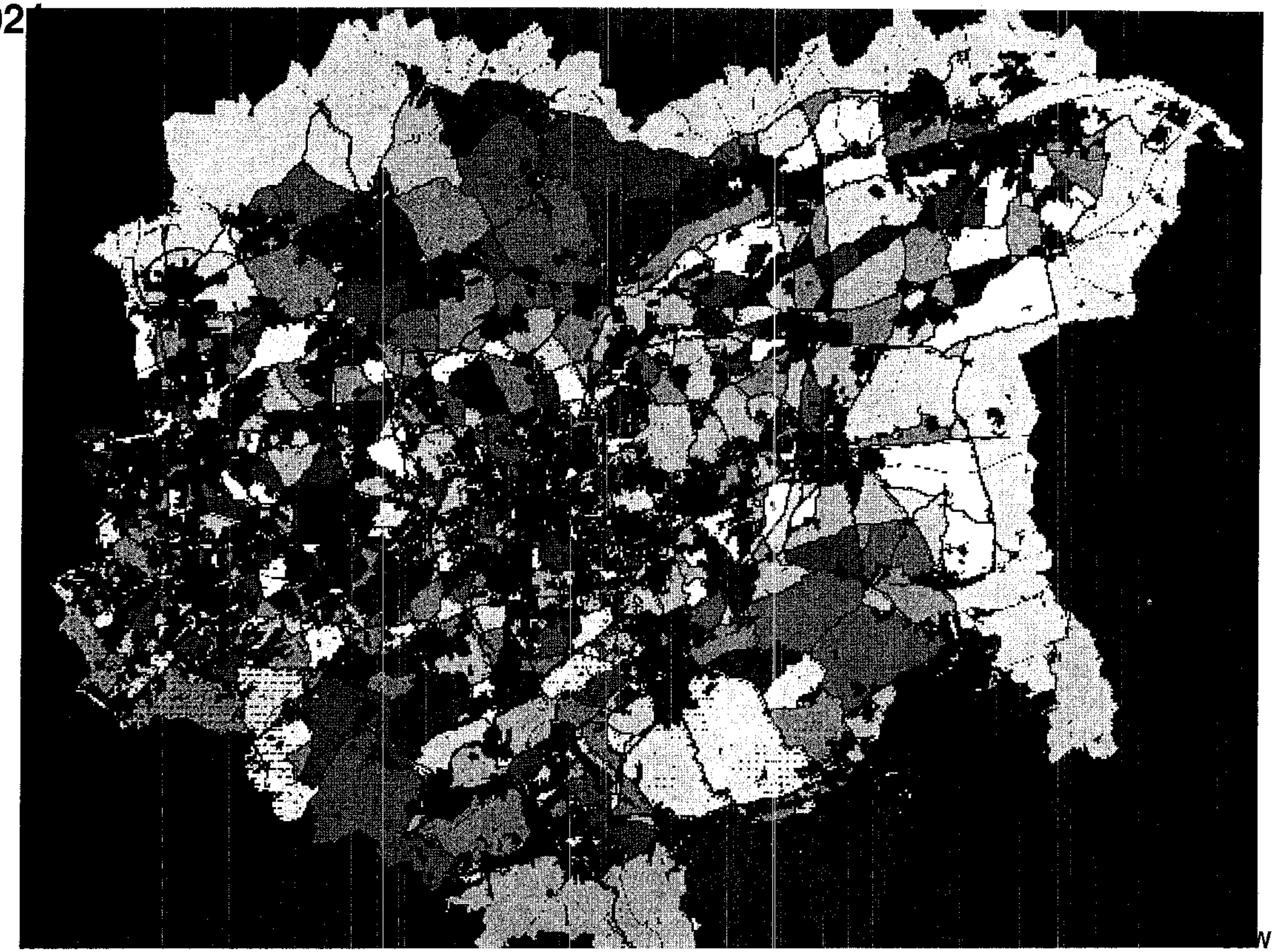
Open space
202



CQ535

Fragmentation of open space

202



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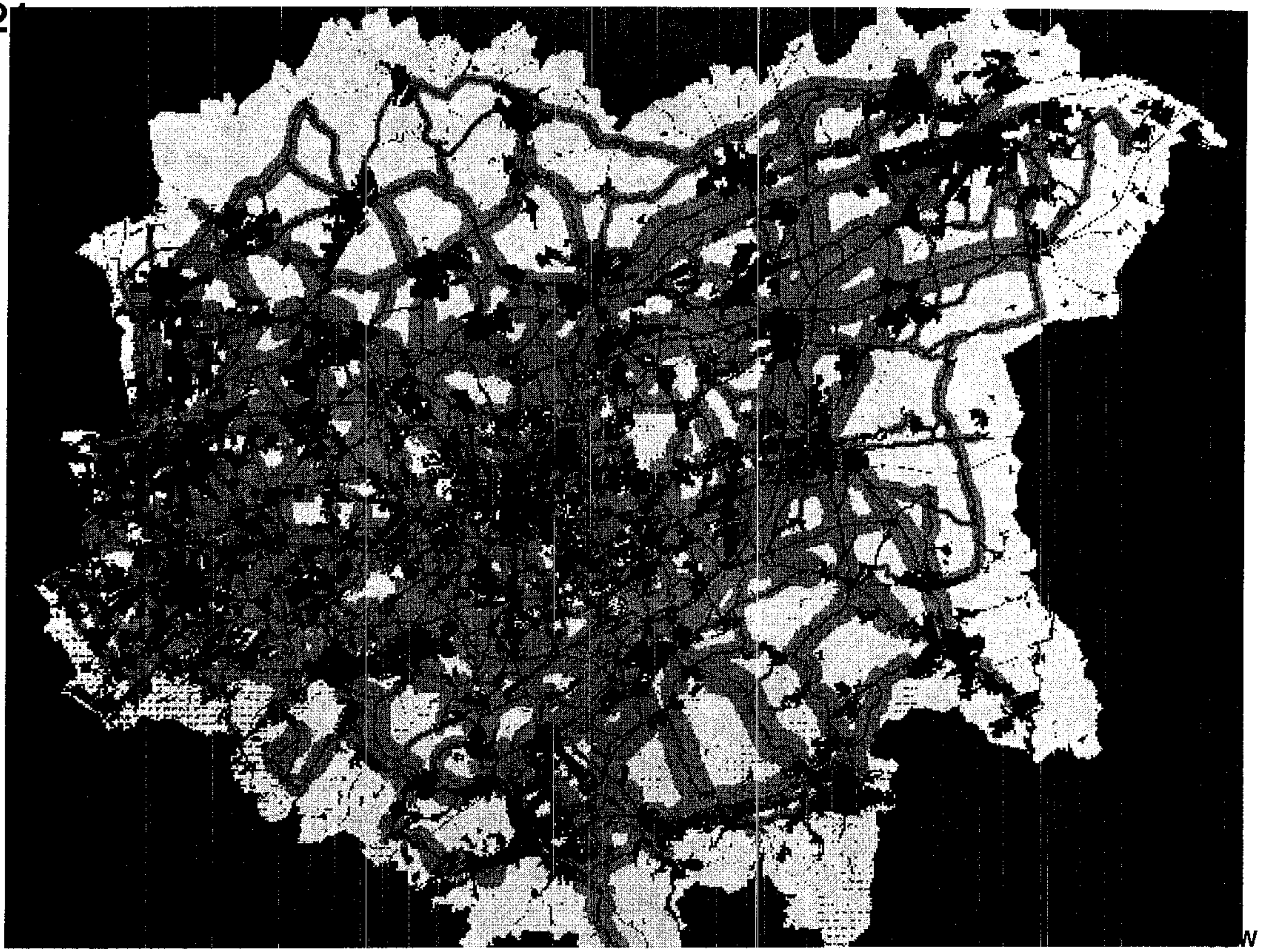
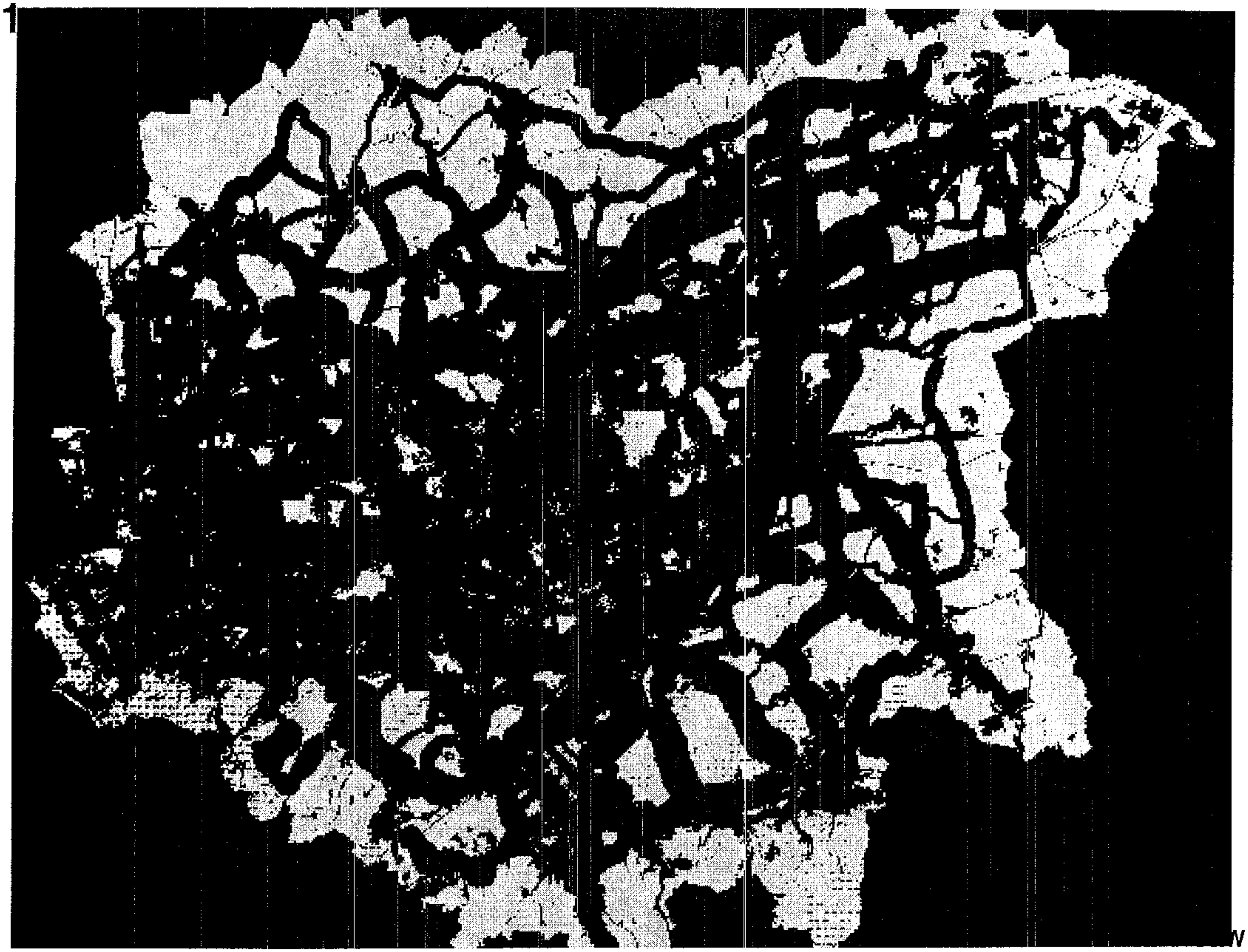
Traffic noise and open space
202



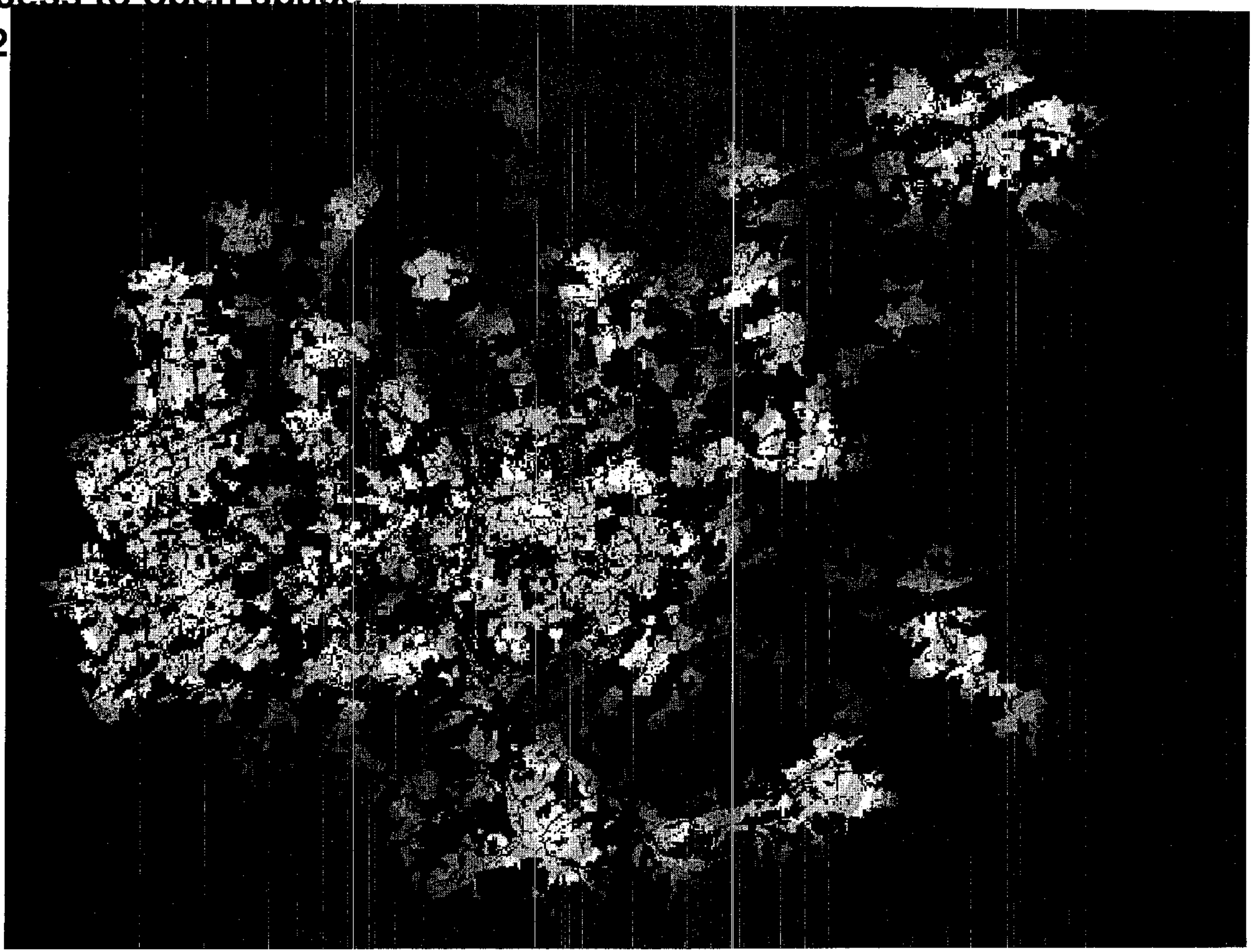
CQ535

CQ535

Quality of open space
2021



Access to open space
202



CQ535

Conclusions

The integration of environmental models in land-use transport models requires the modelling of environmental i***mpacts*** and environmneetal ***feedback***.

Existing land-use transport models lack the **spatial resolution** required by environmental models.

Spatial disaggregation of the ***output*** of land-use transport models permits the modelling of environmental ***impacts*** but only limited modelling of environmental ***feedback***.

Only spatially disaggregate microsimulation land-use transport models permit the modelling of both environmental ***impacts*** and environmental ***feedback***.

More information

PROPOLIS

http://www.ltcon.fi/propolis

PROPOLIS Dortmund model

http://irpud.raumplanung.uni-dortmund.de/irpud/pro/...
... mod/mod_e.htm
... co2/co2_e.htm